2017 The Korean Institute of Surface Engineering

STMT 2017
International Symposium on Surface Treatment & Modification Technologies

November 22-24 2017
Jeju National University, Jeju, South Korea

Organized by  The Korean Institute of Surface Engineering

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The Korean Institute of Surface Engineering

Supported by
Anton-Paar Korea
Hybrid Interface Materials
Jisang Electric Co., LTD.
Boochang Tech Co., LTD.
KJ MEDIATECH Co., Ltd.,
BANWOL PLATING INDUSTRY COOPERATIVE,
Youil Metal Co., Ltd.,
Samil Metal Ind Co., Ltd.,
Dae Hwa Metal Co., Ltd.,
Sewon Metal Co., Ltd.
Korea Surface Treatment Industry Cooperative
YKMC Co., Ltd.
AT FRONTIER Co., Ltd.
eSang Networks Co., Ltd
Location

- From the Jeju Airport

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<td>Travel time: about 20 min.</td>
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- From City

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<td>Bus</td>
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<td>about 20 min.</td>
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Venue

Ara Convention Hall, Jeju National University

- Reception Desk: Ara Convention Hall Robby
- Poster: Ara Convention Hall Robby
- Plenary: Conference room
- Banquet: Global house
- 11/22(Wed)-11/24(Fri) Lunch: Global house
COMMITTEES

Prof. Han-cheol Choe (Chosun University, Korea)

Prof. Myeong-Hoon Lee (Korea Maritime University, Korea)

Prof. Junghoon Joo (Kunsan University, Korea)

Dr. Dong-Hyun Kim (MSC, Korea)

Dr. Sungmo Moon (KIMS, Korea)

Prof. Bongyoung Yoo (Hanyang University, Korea)

Dr. Jaein Jung (RIST. Korea)

Prof. Poong Gun Song (Pusan University, Korea)

Prof. Seong-Jong Kim (Mokpo National Maritime University, Korea)

Prof. Yuan Xia (Chinese Academy of Science, China)

Prof. Wenbin Xue (Beijing Normal University, China)

Prof. Her-Hsiung Huang (National Yang-Ming University, Taiwan)

Prof. Jyh-Wei Lee (Ming Chi University of Technology, Taiwan)

Prof. Hiroki Habazaki (Hokkaido University, Japan)
PLENARY SPEAKERS

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<tr>
<th>Name</th>
<th>Affiliation</th>
<th>Presentation Title</th>
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<tbody>
<tr>
<td>Prof. Her-Hsiung Huang</td>
<td>National Yang-Ming University (TWN)</td>
<td>Biological Response to Surface-modified Titanium and Zirconia Dental Implants</td>
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<tr>
<td>Prof. Ping Wu</td>
<td>Singapore University of Technology and Design (SG)</td>
<td>Surface modelling for semiconductors and alloys based on physical and mechanical chemistry</td>
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<td>Prof. Nagahiro Saito</td>
<td>Nagoya University (JP)</td>
<td>Solution Plasma Catalyst for Nanomaterials Synthesis</td>
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<tr>
<td>Prof. Nosang Vincent Myung</td>
<td>UCRiverside (USA)</td>
<td>Electrochemically Synthesized Advanced Functional Nanomaterials Old Stagnant Technology Becoming Hot New Technology</td>
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## INVITED SPEAKERS

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<th>Paper Title</th>
<th>Name</th>
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<tbody>
<tr>
<td>1</td>
<td>Application of Optic Emission Spectroscopy in Plasma Electrolytic Oxidation</td>
<td>Prof. Wenbin Xue</td>
<td>Beijing Normal University(CN)</td>
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<tr>
<td>2</td>
<td>Improved heat dissipation using PEO films on Al6061 alloy</td>
<td>Prof. Bongyoung Yoo</td>
<td>Hanyang University(KR)</td>
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<td>3</td>
<td>The fabrication of tungsten oxide layers on pure Al substrate by plasma electrolytic oxidation in sodium tungstate based electrolytes</td>
<td>Prof. Yingliang Cheng</td>
<td>Hunan University(CN)</td>
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<tr>
<td>4</td>
<td>Fabrication of nanostructures and functionalization on various polymer substrates using linear ion beam source</td>
<td>Dr. Doguen Kim</td>
<td>Korea Institute of Materials Science(KR)</td>
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<tr>
<td>5</td>
<td>Surface modification of carbon materials</td>
<td>Dr. Tomonaga Ueno</td>
<td>Nagoya University(JP)</td>
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<td>6</td>
<td>High Performance Zinc Alloys</td>
<td>MR. Marco Roesch</td>
<td>SurTec International(GER)</td>
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<td>7</td>
<td>Surface treatment of metals based on plasma electrolytic oxidation method</td>
<td>Dr. Sungmo Moon</td>
<td>Korea Institute of Materials Science(KR)</td>
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<td>8</td>
<td>Plasma Electrolytic Oxidation for Protective Materials</td>
<td>Prof. Younggun Ko</td>
<td>YEUNGNAM UNIVERSITY(KR)</td>
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<td>9</td>
<td>Surface enhanced Raman Scattering (SERS) Substrates for Ultrasensitive Chemical Sensors</td>
<td>Dr. Dong-Ho Kim</td>
<td>Korea Institute of Materials Science(KR)</td>
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<td>10</td>
<td>Solution plasma treatment of TiO2 materials for enhancing the photocatalytic activities</td>
<td>Prof. Chiaki Terashima</td>
<td>Tokyo University of Science(JP)</td>
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<td>11</td>
<td>High aspect ratio anodic TiO2 nanotubes with dopants for water oxidation: single step vs. potential shock vs. underpotential shock</td>
<td>Prof. Jinsub Choi</td>
<td>Inha University(KR)</td>
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<td>12</td>
<td>Multifunctional Omniphobicity of Oil-Impregnated Nanoporous Anodic Aluminum Oxide Surfaces</td>
<td>Prof. Junghoon Lee</td>
<td>Pukyong National University(KR)</td>
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<td>13</td>
<td>In situ observation of adsorption/desorption and direct electron transfer reaction of cytochrome c on solid/liquid interfaces with slab optical waveguide spectroscopy</td>
<td>Dr. Naoki Matsuda</td>
<td>AIST(JP)</td>
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<td>14</td>
<td>Electrolyte/Electrode Interface Engineering Toward Advanced Lithium-ion Batteries</td>
<td>Prof. Nobuyuki Zettsu</td>
<td>Shinshu University(JP)</td>
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<td>15</td>
<td>Surface-Mediation of Aluminium Powders for Advanced Energetic Applications</td>
<td>Dr. KyungTae Kim</td>
<td>Korea Institute of Materials Science(KR)</td>
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<td>16</td>
<td>The improved corrosion resistance and fatigue properties of 2024 Al alloy treated by SMAT and MAO process</td>
<td>Prof. Yaming Wang</td>
<td>Harbin Institute of Technology(CN)</td>
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<td>17</td>
<td>One-Process Fabrication of Nanoporous Sn-SnO₂-TiO₂/Cu₆Sn₅ Composite Films on Cu by Hybrid Electrodeposition for High Capacity Lithium-ion Battery Anodes</td>
<td>Prof. Song-Zhu Kure-Chu</td>
<td>Nagoya Institute of Technology(JP)</td>
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<td>18</td>
<td>Nature Inspired Anti-stain Surface Treatment for Housing Wet Area</td>
<td>Dr. Norifumi Isu</td>
<td>LIXIL Corp. (JP)</td>
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<td>19</td>
<td>Effect of Anodizing Conditions on Porous Alumina Formation at Selected area with Solution Flow type Micro-Droplet Cell</td>
<td>Prof. Masatoshi Sakairi</td>
<td>Hokkaidou University(JP)</td>
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<td>20</td>
<td>Applications of Pack Cementation-based and Plasma-based Surface Treatment and Modification Technologies on Engineering Alloys</td>
<td>Prof. Jyh-Wei Lee</td>
<td>Ming Chi University of Technology(TW)</td>
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<td>21</td>
<td>Biofilms and Surface Finishing</td>
<td>Prof. Hideyuki Kanematsu</td>
<td>Suzuka College (JP)</td>
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<td>22</td>
<td>Reduction of odor from industrial material by using vegetable polyphenol and ozone water</td>
<td>Prof. Keiichiro Sano</td>
<td>Kanto Gakuin University(JP)</td>
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<td>23</td>
<td>Effects of crystallographic texture and nano-scaled features on corrosion behaviors of electrodeposited zinc and their chromium passivation layers</td>
<td>Dr. Narin Jantaping</td>
<td>Chulalongkorn University &amp; Okuno-Auromex (Thailand) Co., Ltd. (TW)</td>
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<td>24</td>
<td>Applications of Photocatalysis in Biology</td>
<td>Prof. Kazuya Nakata</td>
<td>Tokyo University of Science(JP)</td>
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<td>25</td>
<td>Non-cyanide Cu-Sn Alloy Plating Solution Using Tetrakis-(2-hydroxypropyl)-ethylenediamine as a Complexing Agent</td>
<td>Dr. Nguyen Van Phuong</td>
<td>MSC Co. Ltd.(VND)</td>
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<td>26</td>
<td>Development of high hardness and wear resistance composite coatings</td>
<td>Dr. Jiaqian Qin</td>
<td>Chulalongkorn University(TH)</td>
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<td>27</td>
<td>First principles computational study of reaction thermodynamics and kinetics to design key materials for electrochemical energy devices</td>
<td>Prof. Byungchan Han</td>
<td>Yonsei University(KR)</td>
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<td>28</td>
<td>Two-dimensional inhibitors and their anticorrosion properties in sol-gel coating on aluminum alloy</td>
<td>Dr. Mei Yu</td>
<td>Beihang University (CN)</td>
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<tr>
<td>29</td>
<td>Flux Coating Innovation of Inorganic Crystal Layers for Next-Generation Energy and Environmental Applications</td>
<td>Prof. Katsuya Teshima</td>
<td>Shinshu University (JP)</td>
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<tr>
<td>30</td>
<td>Importance of Natural Oxide Film Control of Magnesium Plate</td>
<td>Dr. Hyejeong Kim</td>
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<td>31</td>
<td>Study on alternative electroplating processes for reducing gold usage in electrical connector</td>
<td>Prof. InJoon Son</td>
<td>Kyungpook national university (KR)</td>
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<td>32</td>
<td>Electro and Electroless Plating for the Electronics Industrial Applications</td>
<td>Prof. Jae-Ho Lee</td>
<td>Hongik University (KR)</td>
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<td>33</td>
<td>Highly flexible and transparent IWO electrode for OLEDs and perovskite solar cells</td>
<td>Prof. Han-Ki Kim</td>
<td>KyungHee University</td>
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### Session Time Table

* 22nd November. (Wednesday)

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<th>Time</th>
<th>Ara convention Hall in Jeju National Univ.</th>
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## Session Chair list

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<th>Session</th>
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<td>Korea Institute of Materials Science</td>
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<tr>
<td>(Wednesday)</td>
<td>10:10-12:00</td>
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<td>Room A</td>
<td>Sungmo Moon</td>
<td>Korea Institute of Materials Science</td>
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<td>14:00-15:40</td>
<td>Oral 2</td>
<td>Room A</td>
<td>Wenbin Xue</td>
<td>Beijing Normal University</td>
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<td>16:00-17:50</td>
<td>Oral 3</td>
<td>Room A</td>
<td>Bongyoung Yoo</td>
<td>Hanyang University</td>
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<td>10:10-12:00</td>
<td>Oral 4</td>
<td>Room B</td>
<td>Dong-Hyun Kim/Chiaki Terashima</td>
<td>MSC Co. Ltd./Tokyo University of Science</td>
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<td>14:00-15:40</td>
<td>Oral 5</td>
<td>Room B</td>
<td>Dogeun Kim/Tomonaga Ueno</td>
<td>Korea Institute of Materials Science/Nagoya University</td>
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<td>16:00-17:50</td>
<td>Oral 6</td>
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<td>Jae-Ho Lee/Chiaki Terashima</td>
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<td>Plenary II</td>
<td>Room A</td>
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<td>(Thursday)</td>
<td>10:10-12:00</td>
<td>Oral 7</td>
<td>Room A</td>
<td>Myeong-Hoon Lee</td>
<td>Korea Maritime University</td>
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<td>Oral 8</td>
<td>Room A</td>
<td>Song-Zhu Kure-Chu</td>
<td>Nagoya Institute of Technology</td>
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<td>16:20-18:00</td>
<td>Oral 9</td>
<td>Room A</td>
<td>Masatoshi Sakairi/Yaming Wang</td>
<td>Hokkaidou University/Harbin Institute of Technology</td>
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<td>24 November</td>
<td>08:40-09:20</td>
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<td>Room A</td>
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<td>Korea Institute of Materials Science</td>
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<td>Byungchan Han</td>
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<td>14:00-14:50</td>
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<td>Sungmo Moon</td>
<td>Korea Institute of Materials Science</td>
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<td>Oral 11</td>
<td>Room A</td>
<td>Injoon Son</td>
<td>Kyungpook national University</td>
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<td>16:30-18:00</td>
<td>Oral 12</td>
<td>Room A</td>
<td>Mei Yu</td>
<td>Beihang University</td>
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<tr>
<td>Date</td>
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<td>Poster</td>
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<td>22 November (Wednesday)</td>
<td>13:00-14:00</td>
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<td>Robby</td>
<td>InJoon Son/ Kyoung Lee/ Kyungpook National University</td>
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<td>23 November (Thursday)</td>
<td>13:00-14:00</td>
<td>II</td>
<td>Robby</td>
<td>Jong-Kuk Kim/ InJoon Son/ Kyoung Lee/ Korea Institute of Materials Science/Kyungpook National University</td>
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<td>24 November (Friday)</td>
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<td>III</td>
<td>Robby</td>
<td>InJoon Son/ Kyoung Lee/ Korea Institute of Materials Science/Kyungpook National University</td>
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## Tantative Program Table

### 22 November (Wednesday) Room A

<table>
<thead>
<tr>
<th>No.</th>
<th>Time</th>
<th>Paper Title</th>
<th>Presenting Author</th>
<th>Affiliation</th>
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<tr>
<td></td>
<td>08:00-18:00</td>
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**Room A**

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<tr>
<th>Time</th>
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<tr>
<td>08:40-09:00</td>
<td>Opening of STMT2017</td>
<td>(Chairman: Dr. Sungmo Moon)</td>
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<tr>
<th>Paper Title</th>
<th>Presenting Author</th>
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<tbody>
<tr>
<td>PL-01</td>
<td>Ping Wu</td>
<td>Singapore University of Technology and Design</td>
</tr>
<tr>
<td>09:00-09:50</td>
<td>Application of Optic Emission Spectroscopy in Plasma Electrolytic Oxidation</td>
<td>Wenbin Xue</td>
</tr>
<tr>
<td>SA-02</td>
<td>Improved heat dissipation using PEO films on Al6061 alloy</td>
<td>Bongyoung Yoo</td>
</tr>
<tr>
<td>SA-03</td>
<td>The fabrication of tungsten oxide layers on pure Al substrate by plasma electrolytic oxidation in sodium tungstate based electrolytes</td>
<td>Yingliang Cheng</td>
</tr>
<tr>
<td>SA-04</td>
<td>Characterization of MicroarcOxidation Films Fabricated on Zr-Nb-Sn Alloy in Silicate Solution</td>
<td>Yao Qu</td>
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**Lunch** (Global House)

**Poster session (STMT2017)**

**Room A** (Chairman: Prof. Wenbin Xue)

<table>
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<tr>
<th>Paper Title</th>
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<th>Affiliation</th>
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<tbody>
<tr>
<td>SA-05</td>
<td>Surface treatment of metals based on plasma electrolytic oxidation method</td>
<td>Sungmo Moon</td>
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<tr>
<td>SA-06</td>
<td>Plasma Electrolytic Oxidation for Protective Materials</td>
<td>YoungGun Ko</td>
</tr>
<tr>
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<tr>
<td>15:00-15:20</td>
<td>SA-07</td>
<td>A new method of phenol degradation by microarc plasma electrolysis</td>
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<tr>
<td>15:20-15:40</td>
<td>SA-08</td>
<td>Microarc oxidation / rGO duplex coating formed on aluminum alloy: preparation, microstructure and thermal dissipation properties</td>
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<td>15:40-16:00</td>
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<tr>
<td>16:00-16:30</td>
<td>SA-09 (Invited)</td>
<td>High aspect ratio anodic TiO$_2$ nanotubes with dopants for water oxidation: single step vs. potential shock vs. underpotential shock</td>
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<tr>
<td>16:30-17:00</td>
<td>SA-10 (Invited)</td>
<td>Multifunctional Onmiphobicity of Oil-Impregnated Nanoporous Anodic Aluminum Oxide Surfaces</td>
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<tr>
<td>17:00-17:30</td>
<td>SA-11 (Invited)</td>
<td>In situ observation of adsorption/desorption and direct electron transfer reaction of cytochrome c on solid/liquid interfaces with slab optical waveguide spectroscopy</td>
</tr>
<tr>
<td>17:30-17:50</td>
<td>SA-12</td>
<td>Characterization of In-vitro Bioactivity film on Ti-39Nb-6Zr Alloy Fabricated by Microarc Oxidation</td>
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<tr>
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<td>Opening of STMT2017</td>
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**Room A**

<table>
<thead>
<tr>
<th>PL-01 (Plenary)</th>
<th>09:00-09:50</th>
<th>Surface modelling for semiconductors and alloys based on physical and mechanical chemistry</th>
<th>Ping Wu</th>
<th>Singapore University of Technology and Design</th>
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<tbody>
<tr>
<td>09:50-10:10</td>
<td>Coffee break</td>
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**Room B**

<table>
<thead>
<tr>
<th>SB-01 (Invited)</th>
<th>10:10-10:40</th>
<th>Fabrication of nanostructures and functionalization on various polymer substrates using linear ion beam source</th>
<th>Dogeun Kim</th>
<th>Korea Institute of Materials Science</th>
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</thead>
<tbody>
<tr>
<td>SB-02 (Invited)</td>
<td>10:40-11:10</td>
<td>Surface modification of carbon materials</td>
<td>Tomonaga Ueno</td>
<td>Nagoya University</td>
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<tr>
<td>SB-03 (Invited)</td>
<td>11:10-11:40</td>
<td>High Performance Zinc Alloys</td>
<td>Marco Roesch</td>
<td>SurTec International</td>
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<tr>
<td>SB-04</td>
<td>11:40-12:00</td>
<td>Achieving High Performance Ambipolar MoS2 One-Dimensional Electrical Contact FET Through Plasma Etching</td>
<td>Zheng Yang</td>
<td>Sungkyunkwan University</td>
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<td>12:00-13:00</td>
<td>Lunch (Global House)</td>
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<tr>
<td>13:00-14:00</td>
<td>Poster session (STMT2017)</td>
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**Room A**

<table>
<thead>
<tr>
<th>SB-05 (Invited)</th>
<th>14:00-14:30</th>
<th>Electrochemical Plating of Cu-Sn Alloy in Non-cyanide Solution Using Tetrakis-(2-hydroxypropyl)-ethylendiamine as Complexing Agent</th>
<th>Nguyen Van Phuong</th>
<th>MSC Co. Ltd.</th>
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<tbody>
<tr>
<td>SB-06 (Invited)</td>
<td>14:30-15:00</td>
<td>Solution plasma treatment of TiO2 materials for enhancing the photocatalytic activities</td>
<td>Chiaki Terashima</td>
<td>Tokyo University of Science</td>
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<tr>
<td>SB-07</td>
<td>15:00-15:20</td>
<td>Improvement of sensing performance using Cu$_2$O/SnO$_2$ nanocomposites toward H$_2$S gas at Room Temperature</td>
<td>Nu Si A Eom</td>
<td>Korea Institute of Material Science</td>
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<tr>
<td>SB-08</td>
<td>15:20-15:40</td>
<td>Development of Cr coating to prevent FCCI (Fuel cladding chemical interaction)</td>
<td>Hye-Yeon Koo</td>
<td>Hanyang University</td>
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<td>(Chairman: Prof. Jae-Ho Lee / Prof. Chiaki Terashima)</td>
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<tr>
<td>SB-09</td>
<td>16:00-16:30</td>
<td>Electrolyte/Electrode Interface Engineering Toward Advanced Lithium-ion Batteries</td>
<td>Nobuyuki Zettsu</td>
<td>Shinshu University</td>
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<tr>
<td>SB-10</td>
<td>16:30-17:00</td>
<td>Study on alternative electroplating processes for reducing gold usage in electrical connector</td>
<td>Injoon Son</td>
<td>Kyungpook national University</td>
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<tr>
<td>SB-11</td>
<td>17:00-17:30</td>
<td>Electro and Electroless Plating for the Electronics Industrial Applications</td>
<td>Jae-Ho Lee</td>
<td>Hongik University</td>
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<tr>
<td>SB-12</td>
<td>17:30-17:50</td>
<td>Ni-based incorporation for superior corrosion properties by surface modification</td>
<td>Siti Fatimah</td>
<td>Yeungnam University</td>
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<td>(Chairman: Dr. Sungmo Moon)</td>
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<tr>
<td>PL-02</td>
<td>09:00-09:50</td>
<td>Biological Response to Surface-modified Titanium and Zirconia Dental Implants</td>
<td>Her-Hsiung Huang</td>
<td>National Yang-Ming University</td>
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<td>09:50-10:10</td>
<td>Coffee break</td>
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<tr>
<td>Room A</td>
<td>(Chairman: Prof. Myeong-Hoon Lee)</td>
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<tr>
<td>SA-13</td>
<td>10:10-10:40</td>
<td>The improved corrosion resistance and fatigue properties of 2024 Al alloy treated by SMAT and MAO process</td>
<td>Yaming Wang</td>
<td>Harbin Institute of Technology</td>
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<td>SA-14</td>
<td>10:40-11:10</td>
<td>Applications of Pack Cementation-based and Plasma-based Surface Treatment and Modification Technologies on Engineering Alloys</td>
<td>Jyh-Wei Lee</td>
<td>Ming Chi University of Technology</td>
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<tr>
<td>SA-15</td>
<td>11:10-11:40</td>
<td>Biofilms and Surface Finishing</td>
<td>Hideyuki Kanematsu</td>
<td>Suzuka College</td>
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<tr>
<td>SA-16</td>
<td>11:40-12:00</td>
<td>Applications of Silver Electroplating Method for Enhancement of the Electrical Properties of Silver and Copper Nanowires</td>
<td>Sol-Ji Song</td>
<td>Sungkyunkwan University</td>
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<tr>
<td>Room A</td>
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<td>SA-17</td>
<td>14:00-14:30</td>
<td>Nature Inspired Anti-stain Surface Treatment for Housing Wet Area</td>
<td>Norifumi Isu</td>
<td>LIXIL Corp.</td>
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<tr>
<td>SA-18</td>
<td>14:30-15:00</td>
<td>One-Process Fabrication of Nanoporous Sn-SnO2-TiO2/Cu6Sn5 Composite Films on Cu by Hybrid Electrodeposition for High Capacity Lithium-ion Battery Anodes</td>
<td>Song-Zhu S. Kure-Chu</td>
<td>Nagoya Institute of Technology</td>
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<tr>
<td>Session</td>
<td>Time</td>
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<td>Speaker</td>
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<td>SA-19</td>
<td>15:00-15:30</td>
<td>Effect of Anodizing Conditions on Porous Alumina Formation at Selected area with Solution Flow type Micro-Droplet Cell</td>
<td>Masatoshi Sakairi</td>
<td>Hokkaidou University</td>
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<tr>
<td>SA-20</td>
<td>15:30-15:50</td>
<td>Modified Cyclic Voltammetry Stripping Analysis to Monitor Chemical Balance of Copper Electroplating Bath</td>
<td>SeungHoe Choe</td>
<td>Korea Institute of Materials Science</td>
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<td>16:00-16:20</td>
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<td>(Chairman: Masatoshi Sakairi / Porf. Yaming Wang)</td>
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<tr>
<td>SA-21</td>
<td>16:20-16:50</td>
<td>Highly flexible and transparent IWO electrode for OLEDs and perovskite solar cells</td>
<td>Han-Ki Kim</td>
<td>Kyung Hee University</td>
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<tr>
<td>SA-22</td>
<td>16:50-17:20</td>
<td>Reduction of odor from industrial material by using vegetable polyphenol and ozone water</td>
<td>Keiichiro Sano</td>
<td>Kanto Gakuin University</td>
</tr>
<tr>
<td>SA-23</td>
<td>17:20-17:40</td>
<td>Copper-Cobalt Oxide Nanosheets Catalyst Array on Nickel Foam for Oxygen Evolution Reaction</td>
<td>Woo-Sung Choi</td>
<td>Korea Institute of Materials Science</td>
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<tr>
<td>SA-24</td>
<td>17:40-18:00</td>
<td>Optimization of Passivator and Corrosion Resistance of Cr-III based Conversion Coating on Hot-dip Zn55Al Coating</td>
<td>Pan Jie</td>
<td>China University of Petroleum East China</td>
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<td>PL-03 (Plenary)</td>
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<td></td>
<td>08:40-09:20</td>
<td>Electrochemically Synthesized Advanced Functional Nanomaterials Old Stagnant</td>
<td>Nosang V. Myung</td>
<td>University of California-Riverside</td>
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<td>Technology Becoming Hot New Technology</td>
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<td>09:20-09:40</td>
<td>Coffee break</td>
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<td>SA-25 (Invited)</td>
<td>Narin Jantaping</td>
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<td></td>
<td>09:40-10:10</td>
<td>Effects of crystallographic texture and nano-scaled features on corrosion behaviors of electrodeposited zinc and their chromium passivation layers</td>
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<td>Chulalongkorn University &amp; Okuno-Auromex (Thailand) Co., Ltd.</td>
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<td>SA-26 (Invited)</td>
<td>Dong-Ho Kim</td>
<td>Korea Institute of Materials Science</td>
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<td>10:10-10:40</td>
<td>Surface enhanced Raman Scattering (SERS) Substrates for Ultrasensitive Chemical Sensors</td>
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<td>SA-27 (Invited)</td>
<td>Kazuya Nakata</td>
<td>Tokyo University of Science</td>
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<td>10:40-11:10</td>
<td>Applications of Photocatalysis in Biology</td>
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<td>SA-28 (Invited)</td>
<td>KyungTae Kim</td>
<td>Korea Institute of Materials Science</td>
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<td>11:10-11:40</td>
<td>Surface-Mediation of Aluminium Powders for Advanced Energetic Applications</td>
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<td>SA-29</td>
<td>Yunfeng Wu</td>
<td>Harbin Institute of Technology</td>
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<td>11:40-12:00</td>
<td>In vivo study of microarc oxidation coated Mg stent to heal bone trauma defect</td>
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<td>PL-04 (Plenary)</td>
<td>Nagahiro Saito</td>
<td>Nagoya University</td>
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<td></td>
<td>14:00-14:50</td>
<td>Solution Plasma Catalyst for Nanomaterials Synthesis</td>
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<tr>
<td>SA-30 (Invited)</td>
<td>15:00-15:30</td>
<td>First principles-base Computational Study on Creative Design of Key Materials for Renewable Energy Devices</td>
<td>Byungchan Han</td>
<td>Yonsei University</td>
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<tr>
<td>SA-31 (Invited)</td>
<td>15:30-16:00</td>
<td>Two-dimensional inhibitors and their anticorrosion properties in sol-gel coating on aluminum alloy</td>
<td>Mei Yu</td>
<td>Beihang University</td>
</tr>
<tr>
<td>SA-32</td>
<td>16:00-16:20</td>
<td>Synthesis of Ni Catalyst with CeO₂/La₂O₃ for Hydrogen Evolution in Alkali Solution</td>
<td>MyeongJe Jang</td>
<td>Korea Institute of Materials Science</td>
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| 16:20-16:30 | Coffee break |

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<tr>
<td>SA-33 (Invited)</td>
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<td>SA-34 (Invited)</td>
<td>17:00-17:30</td>
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<tr>
<td>SA-35 (Invited)</td>
<td>17:30-18:00</td>
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| 18:00-20:00 | Banquet(Global House) |
### Wednesday Afternoon Poster Sessions

22 November, 2017  
(Time: 13:00 p.m. - 14:00 p.m.)  
Room: Robby  
(Chairman : Prof. InJoon Son, Prof. Kiyong Lee)

<table>
<thead>
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<th>No.</th>
<th>Paper Title</th>
<th>Presenting Author</th>
<th>Affiliation</th>
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<tbody>
<tr>
<td>PS-1</td>
<td>Evaluation on Sensitization of Stainless Steel 304 Steel by Artificial Aging and DL-EPR Test</td>
<td>Min-Su Han</td>
<td>Mokpo Maritime University</td>
</tr>
<tr>
<td>PS-2</td>
<td>Enhancement of Cavitation-Erosion Resistance in Marine Environment for Austenitic Stainless Steel by the DC Glow Discharge</td>
<td>Jung-Hyung Lee</td>
<td>Mokpo Maritime University</td>
</tr>
<tr>
<td>PS-3</td>
<td>The Effect of Gaseous Nitriding Phases Controlled with Customized Lehrer Diagram of AISI 4140 to Enhance the Fatigue Resistance of the Steel</td>
<td>Sunkwang Kim</td>
<td>Korea Institute of Industrial Technology (KITECH)</td>
</tr>
<tr>
<td>PS-4</td>
<td>Microstructure and Oxidation Behavior of Nanostructured Ti–Si–B–C–N Films Deposited by Unbalanced Magnetron Sputtering</td>
<td>Hyundong Kim</td>
<td>Korea Institute of Industrial Technology (KITECH)</td>
</tr>
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2. Biological Response to Surface-modified Titanium and Zirconia Dental Implants  
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3. Electrochemically Synthesized Advanced Functional Nanomaterials Old Stagnant Technology Becoming Hot New Technology  
   - Nosang V. Myung  
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4. Solution Plasma Catalyst for Nanomaterials Synthesis  
   - Nagahiro Saito(Nagoya University)
Surface modelling for semiconductors and alloys based on physical and mechanical chemistry

Ping WU*

Entropic Interface Group, Singapore University of Technology and Design, Singapore
*wuping@sutd.edu.sg

Currently, surface treatment and modification research is dominated by the trial and error approach – that is, a set potential materials/processes is tested on a one-by-one bases in order to determine the appropriate surface performance. However, such approach is time-consuming and labour-intensive. Most importantly, the results might not lead to the best desired solution in a particular time window. Consequently, the development of design computational methods for surface treatment and modification research is highly desirable at this particular stage, which will be outlined and discussed in this plenary lecture. New surface research opportunities based on mechanochemistry principles will also be highlighted.

Multiscale computer modelling techniques, like the bulk chemical equilibrium (solid-gas reactions), the electronic structure (defect interface chemistry), and the charge/mass transportation, are the basic components of the design methodology of surface/interfaces. Modelling examples will be given for three applications; (1) chemical gas sensors – high sensitivity/selectivity, short response time and super stability, (2) solar cells – high photovoltaic efficiency and photo-catalytic performance, and (3) corrosion – excellent anti-oxidation performance.

These surface modelling techniques are transformative to the design of general semiconductor and alloy interfaces beyond just gas sensing, solar cells and corrosion research. For instance, they may lead to great innovation of wearable/embeddable technologies for IOT applications. There are plenty of things to explore at surfaces, and computer modelling is a useful tool to release the real power of surfaces towards improving human lifestyle.
Biological Response to Surface-modified Titanium and Zirconia Dental Implants

Her-Hsiung Huang*

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*hhhuang@ym.edu.tw

Surface characteristics of dental implants play important role in their biological response. Suitable surface modifications, such as physical, chemical, electrochemical and/or biological treatments, can enhance the biological response to dental implants. The biological response may include the response of various biological species, such as protein adsorption, blood coagulation, cell growth and bacterial adhesion, etc. The biological response to dental implants play positive effect on the osseointegration of implants. The study on the various biological responses can be in vitro, in vivo and in situ. In my talk, some potential surface modifications, including physical, chemical, electrochemical and/or biological methods, for dental implants (titanium and zirconia) developed in my research group will be introduced. The in vitro, in vivo and in situ studies on the abovementioned biological responses to the surface-modified dental implants will be presented as well.
Electrochemically Synthesized Advanced Functional Nanomaterials
Old Stagnant Technology Becoming Hot New Technology

Nosang V. Myung*

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University of California-Riverside Riverside, CA 92521
*myung@engr.ucr.edu

The ever-increasing demands for faster, smaller and less expensive systems have resulted in the development of a novel and cost-effective processes. Electrochemical processes including electrochemical synthesis (e.g., electroplating, electroless plating, galvanic displacement), and anodizing meet the needs of emerging technology. It is one of the easiest and most versatile solution-based synthesis techniques that can be used in a cost-effective and scalable manner. It typically operated near ambient conditions and able to synthesize various materials range from metals, metal oxides, conductive polymers and semiconductors. Precise control over the dimensions, composition, morphology, and degree of crystallinity can be achieved by varying electrodeposition parameters, such as the applied potential, electrolyte concentration, temperature, agitation, and additives. Additionally, the non-equilibrium reaction makes it possible to synthesize stoichiometric or non-stoichiometric materials easily without changing other aspects of the material properties. In this presentation, various nanoengineered materials synthesized by electrochemical synthesis will be reviewed and their applications toward applications including thermoelectrics, biological and chemical sensor arrays will be discussed.
Solution Plasma Catalyst for Nanomaterials Synthesis

Nagahiro Saito\textsuperscript{a,b,c}, Kazuo Hashimi\textsuperscript{b}, Maria Antoaneta Bratescu\textsuperscript{b,c}

\textsuperscript{a} Department of Chemical Systems Engineering, Graduate School of Engineering, Nagoya University, Japan.
\textsuperscript{b} Institutes for Innovation for Future Society, Nagoya University, Japan.
\textsuperscript{c} Japan Research for Evolutional Science and Technology (CREST), Japan Science and Technology Agency (JST), Saitama, Japan

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Solution plasma (SP) is one of non-thermal plasma in the liquid phase. SP provides us selective reactions in reactants molecules in organic and aqueous solution, eg., C-H activation linking with cyclic organics, reduction reactions for transition metals complex. In these reactions, the primary reaction pathway is charge transfers (CTs) at the interface of plasma and solution, not the reactions in plasma. The reaction pathway from occupied molecular orbitals (MOs) of reactants to plasma and from plasma to un-occupied MOs. The CTs reactions produce the cation radicals in the solution. For examples, water cation radicals and benzene cation radicals were seen in aqueous and benzene solutions, respectively. The reaction selectivity is determined by the comparisons of the wall potential at the solution and plasma and the occupied and unoccupied MOs of reactants. Thus we can design the reactions and products induced by SP.

We have been already successful to synthesize the hetero-graphene, some organic complex embedded graphene, reduced molecular weight natural products, CNT with function head groups through amide bonds formation transition metal oxides sheet, metal clusters (less than 2 nm), core-shell metal nanoparticles, etc..

In this presentation, we show the SP reaction design and synthesis from organic molecules to several types of hetero-graphene. For example, we showed 18-crown-6-ether embedded graphene synthesized from benzene and 18-crown-6-ether solution by SP. the Raman Shift and TEM images of hetero-graphene synthesized from a-e organic molecules in organic solutions. Fig.1 shows the reactions and TEM images, SEAD pattern, and STM image. TEM images and SAED pattern indicate the several layers stacked graphene. ABAB stack slightly rotated around [002] direction. STM images showed the presence of holes in graphene sheets.

Acknowledgments

This research was partially supported by JST/CREST(GJPMJCR12L1) grant.
Oral Session
Application of Optic Emission Spectroscopy in Plasma Electrolytic Oxidation

Wenbin Xue$^{a,b,*}$, Run Liu$^a$, Xuan Yang$^{a,b}$, Xiaoyue Jin$^b$, Jiancheng Du$^{a,b}$

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Plasma spectroscopy is a sensitive diagnostic tool of plasma characteristics to establish a more complete and reliable arsenal of atomic parameters. The optical emission spectroscopy (OES) has been utilized to investigate the complex plasma discharge phenomenon during the growth of ceramic coating of plasma electrolytic oxidation (PEO) or microarc oxidation (MAO). The elements involved in the plasma discharge can be identified by the OES spectrum. Plasma parameters such as electron temperature and density as well as atomic ionization degree in plasma zone can be calculated from the OES spectral lines.

In this work, the optical emission spectra during the PEO process of Al and Mg alloys under a constant voltage mode were recorded, and the electron temperature, electron density and atomic ionization degree in plasma discharge zone with oxidation time were calculated on basis of OES. The discharge behaviors, high spike peaks of electron temperature profiles and formation process of PEO coatings were discussed. The illumination intensity of plasma discharge and the temperature in the interior of alloy were measured. Combining the surface morphology and cross-sectional microstructure with the optical emission spectra and illumination at different discharge stage, a new discharge model in the growth of PEO ceramic coatings was proposed. It is found that the generation of these spike peaks depended on the spark density and illumination intensity rather than the appearance of large discharge sparks, which was different from the previous viewpoint.

In addition, OES was also utilized to study the growth of PEO coating on metal matrix composites (MMC). The results show that the elements from the reinforcement phases can be found in the OES spectrum, which indicates that the reinforcement phases involved in the plasma discharge, and the average electron temperature is about 5000K-7000K during the plasma discharge. It is believed that most of reinforcement phases are molten firstly and then oxidized.
Improved heat dissipation using PEO films on Al6061 alloy

Bongyoung Yoo*, Jung Woo Choi, Dong Hyuk Shin

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*byyoo@hanyang.ac.kr, dhshin@hanyang.ac.kr

In this work, heat dissipation characteristics of PEO (plasma electrolytic oxidation) films on Al6061 alloy was studied. The PEO films were formed by the application of anodic currents in KOH-based electrolytes with either carbon nanotube (CNT), or various weight percent of boron nitride nanotube (BNNT). The morphologies of the PEO films were observed by scanning electron microscopy and compositional analyses were carried out with energy dispersive X-ray spectroscopy. The surface roughness of the PEO-treated samples was examined by means of a non-contact optical 3D surface measurement equipment. Also Fourier transform infrared spectrometer was conducted to measure the thermal emissivity of samples. Heat dissipation properties by PEO films with boron nitride nanotubes appeared to be superior to those with carbon nanotubes. The principle of heat dissipation via porous PEO films will be discussed in detail in this presentation.
The fabrication of tungsten oxide layers on pure Al substrate by plasma electrolytic oxidation in sodium tungstate based electrolytes

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Plasma electrolytic oxidation (PEO) of pure Al has been carried out in sodium tungstate based electrolytes. In dilute sodium tungstate electrolytes, e.g. 5 and 10 g l\(^{-1}\) Na\(_2\)WO\(_4\)•2H\(_2\)O, instead of the formation of a thick coating on the Al metal, powders in nano and micro sizes have been synthesized and suspended in the electrolyte by PEO treatment. XRD and TEM show that the powders are mainly monoclinic WO\(_3\). The as-prepared powders show photocatalytic ability by degradation of 92.4 % methyl orange solution within 120 minutes. With the increasing of the concentration of Na\(_2\)WO\(_4\)•2H\(_2\)O to 16 g l\(^{-1}\), uniform WO\(_3\) oxide layers can be formed on the metal, however, fine powders are also present in the electrolyte. The oxide layer formed on the metal in 16 g l\(^{-1}\) electrolyte also shows excellent photocatalytic ability. The mechanism for forming the WO\(_3\) powders has been proposed. It is believed that the lower melting and boiling points and the tendency of sublimation for WO\(_3\) have caused the vaporization of the WO\(_3\) in the discharge channels, forming the fine powders after cooling by the electrolyte. The phenomenon observed in the experiment has also been analyzed from the thermodynamic data of the respective oxides of alumina and tungsten oxide. The adding of additional sodium aluminate to the tungstate-based electrolytes can prevent the forming of fine powders and lead to an increased coating formation rate and black coating color. The photocatalytic properties of the black coatings have also been evaluated.
Characterization of Microarc Oxidation Films Fabricated on Zr-Nb-Sn Alloy in Silicate Solution

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The protective films on Zr-Nb-Sn alloy were formed by microarc oxidation (MAO) at different voltage in silicate solution. The morphology, composition and phase constituent of the films at different treating time were analyzed by SEM, XRD, Raman spectra. Corrosion resistance of MAO films was evaluated by potentiodynamic polarization and electrochemical impedance spectroscopy. Furthermore, their dielectric properties were tested by dielectric spectrometer.

It is found that the MAO films on Zr-Nb-Sn alloy contain two layers: a dense layer with more t-ZrO\textsubscript{2} and a loose layer with more m-ZrO\textsubscript{2}. The films have high microhardness. Corrosion current reduce 2 or 3 order of magnitudes and corrosion resistance is obviously increase. Furthermore, conductivity of films increases when the environment temperature rises up in range of -100°C~250°C and 10\textsuperscript{-3}Hz~10\textsuperscript{6}Hz. At the same frequency, the permittivity increase with the increase of temperature from -100°C~250°C. Under the same temperature, permittivity increases with decrease of frequency from 10\textsuperscript{-3}Hz~10\textsuperscript{6}Hz. Before the peak of tan\theta, there is same transformation law as well as permittivity, but when the peak come out, the peak moves from low frequency to high frequency while the temperature rises.
Surface treatment of metals based on plasma electrolytic oxidation method

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In this presentation, surface treatment of metals by plasma electrolytic oxidation (PEO) will be introduced, based on arc generation and oxide film breakdown, formation and growth under the application of high anodic voltage. The effects of alloy composition, electrolyte composition and form and magnitude of the applied anodic current density on the formation behavior of PEO films on Al and Mg alloys will be reported, based on in-situ observation of arc generation, voltage-time curves, and morphological observation of the PEO films. Electrolytes employed for the PEO treatment were composed of various concentrations of NaOH, Na\textsubscript{2}SiO\textsubscript{3}, NaBO\textsubscript{2} and Na\textsubscript{2}CO\textsubscript{3}. Random generation of small size micro-arcs was observed over the whole surface with high arcing voltage when PEO film growth rate is low, while group arcings were observed to travel along the edges first and then towards the center of the specimen surface. Arcing voltage decreased with increasing NaOH and Na\textsubscript{2}CO\textsubscript{3} concentrations while it increased with increasing Na\textsubscript{2}SiO\textsubscript{3} concentration. Local burning, which is the phenomenon of repeatedly occurring arcs at the same site, was observed when electrolyte composition is not optimized or when the anodic films are thickened too much. In this presentation, the mechanism of arc generation and film formation during the PEO treatment of Al and Mg alloys will be discussed in more detail.

Plasma Electrolytic Oxidation for Protective Materials

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The presentation reviewed the current development of protective materials subjected to plasma electrolytic oxidation (PEO) giving rise to the oxide layer formed on the metal substrate. First, the effects of PEO processing parameters on the formation of the oxide layer were introduced. In addition, the electrochemical response was discussed based on polarization and impedance behavior.

Keywords: Plasma Electrolytic Oxidation, Corrosion, Incorporation
A new method of phenol degradation by microarc plasma electrolysis

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Phenolic substances in industrial wastewater constitute harmful effects for humans and ecosystems. With regard to its fast removal rate and environmental friendliness, the plasma technology is regarded as a promising degradation method for organic pollutions. The microarc plasma electrolysis treatment can dissociate the water molecules at high temperature into oxidizing substances such as O\textsubscript{3}, H, ·OH, Cl·, etc., which can directly or indirectly act on the organic pollutant. Meanwhile, the thermal effects of plasma discharge can decompose some refractory organics.

In this paper, the microarc plasma electrolysis was tentatively performed to degrade the phenol in aqueous solution by vapour-gaseous envelope discharge around the metal electrode. Degradation efficiency of phenol was measured and the intermediate products were evaluated. The suspended particles in solution were analyzed and the decomposition mechanism of phenol in the process of microarc plasma degradation was discussed. The instantaneous current efficiency reached a peak value firstly and then decreased with the discharge time. In the microarc plasma region, the Cl substituted the hydrogen on benzene ring in the initial time, which was replaced by hydroxyl immediately, then the polyhydroxy phenol was easily decomposed. In addition, optical emission spectroscopy (OES) was carried out to characterize the plasma features during the discharge process. The temperature of electron around the microarc discharge envelope reached about 4000K, thus the phenol was partly carbonized to become graphite particles. The microarc plasma electrolysis is a promising approach to degrade quickly the phenol in wastewater.
Microarc oxidation / rGO duplex coating formed on aluminum alloy: preparation, microstructure and thermal dissipation properties

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The lifetime and luminescence efficiency of Light emitting diode (LED) tend to drop rapidly with the increasing P-N junction temperature (TJ). To enhance the heat dissipation of aluminum alloy radiator for LED, a high emissivity and hydrophobic coating was fabricated by microarc oxidation (MAO) combined with spinning reduced graphene oxide (rGO). The effects of uncoated aluminum, MAO coated, and MAO/rGO duplex coated radiator on infrared emissivity, contact angle, anti-corrosion and heat dissipation properties were comparatively investigated. The results show that the static water contact angles of aluminum alloy, MAO and rGO/MAO coatings are 72.4°, 22.6° and 114.2°, respectively. The electrochemical measurements indicate that the corrosion current of aluminum alloy substrate has been significantly decreased by the MAO and rGO/MAO coatings. The EIS measurement suggested that the MAO and rGO/MAO coatings effectively inhibited the aluminum alloy radiator from corrosion. MAO coating exhibits a high emissivity up to 0.8 within 8-20 μm wavelength range, while the rGO/MAO duplex coating further promotes the value by about 0.1, especially the value increases by 0.25 for 3-8 μm wavebands. Due to the enhanced thermal radiation induced by MAO and rGO/MAO coating, the MAO coated, especially the rGO/MAO coated aluminum radiator enables the TJ of LED to drop approximately at 4.5 °C and 5.6 °C, respectively.
High aspect ratio anodic TiO\textsubscript{2} nanotubes with dopants for water oxidation: single step vs.
potential shock vs. underpotential shock

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In the presentation, anodically prepared TiO\textsubscript{2} nanotubes were simultaneously (or through post-treatment) doped with various catalytic foreign elements, such as MnO\textsubscript{2}, Pt, RuO\textsubscript{2} and/or IrO\textsubscript{2}, by electrochemical process for water oxidation applications. We found that more than 1\% of RuO\textsubscript{2} and IrO\textsubscript{2} catalysts can be homogeneously incorporated into high aspect ratio TiO\textsubscript{2} nanotubes by the single step (or potential shock) anodization, in which negatively-charged precursors are simultaneously (or by post-treatment) incorporated into TiO\textsubscript{2} films during anodic oxidation of Ti. For MnO\textsubscript{2} doping, the precursors were easily decomposed into the positively charged metal ions, when it is contacted with F\textsuperscript{-} ions which are main components for the formation of nanotubular TiO\textsubscript{2} during anodization. Thus, since Mn\textsuperscript{2+} were deposited on the counter electrode instead of the simultaneous doping during the single step anodization, the potential shock method, in which the high positive bias is shortly imposed on the prepared TiO\textsubscript{2} nanotubes in the precursor solution immediately after the first anodization, was the unique way to dope MnO\textsubscript{2} into TiO\textsubscript{2} nanotubes. In addition, underpotential shock method, which can suppress the breakdown of oxide by aggressive chloride ions involved in some precursors, will be discussed in detail.

Fig. 1 TEM images of TiO\textsubscript{2} nanotubes with a dopant of RuO\textsubscript{2}.
Multifunctional Omniphobicity of Oil-Impregnated Nanoporous Anodic Aluminum Oxide Surfaces

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Multifunctional omniphobic surfaces that show repellency to a wide range of liquids have arose interests in various application fields, such as anti-corrosion, solar cell, microfluidic devices, biomedical equipment, aircraft and food processing. Especially, a lubricant-infused porous surface provides omniphobic and slippery property without sophisticated surface structures. Moreover, the surface with oil-impregnated porous structures has a capability to reduce bio-contaminations as well as corrosion of metallic materials. Therefore, the porous surfaces with an infusion of lubricant (or oil) are considered as a promising candidate to solve various surface-related problems of conventional materials. In this work, the omniphobic property on an aluminum surface has been realized by impregnating oil within the nanoporous anodic aluminum oxide layer. Due to the immiscibility of perfluorinated oil, which is impregnated in the nanopores, the surface shows the repellency to water as well as organic liquids, thus the liquids have a high mobility on this surface. Moreover, the oil-impregnation allows the nanoporous anodic aluminum oxide surface to diminish the adhesion of bacteria (\textit{Escherichia (E) coli} K-12). The disconnected nanoscale dead-end pore geometry of the anodic aluminum oxide enables the pore to strongly retain the oil even against an external shear flow of water. Since the oil impregnated in the nanopores also inhibits the contact of corrosive liquid on the surface, oil-impregnated anodic aluminum oxide layer enhances the corrosion resistance of aluminum. Completely impregnated oil in the nanoporous anodic oxide by a solvent exchange method allows the redistribution of oil to local damages (e.g., cracks) of anodic oxide, so that the surface also shows the effective self-healing capability.
In situ observation of adsorption/desorption and direct electron transfer reaction of cytochrome c on solid/liquid interfaces with slab optical waveguide spectroscopy

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Introduction
Electron transfer (ET) of cytochrome c (cyt c) is slow, thus direct electron transfer (DET) reaction between proteins and electrodes is rarely observed. They remarked that the ET reaction of cyt c is affected by the electrode pretreatment procedure, solution conditions, impurities in cyt c, etc. In situ observation of ET reaction is of much importance to understand the interfacial phenomena for practical application of proteins, information obtained by electrochemical techniques is not sufficient. Slab optical waveguide (SOWG) spectroscopy can perform in situ observation of UV-vis. absorption spectra from adsorbed molecules on solid/liquid interfaces below monolayer coverage.[1-3]

As a great advantage, SOWG spectral change bring us molecular functionality. We have reported DET reaction of cyt c adsorbed on ITO electrode could be observed by SOWG spectral change due to electrode potential scan, and that cyt c adsorbed on ITO electrodes kept DET activity without addition of any promoters or mediators. These results clearly showed the ability and potential of SOWG spectroscopy for probing the adsorbed kinetics, states, and functionality of proteins on solid/liquid interfaces.

In this presentation, we will report the effect of surface modification on ITO electrode with phosphonic acid compounds self-assembled monolayer (SAM) films on adsorption/desorption and DET reaction of cyt c immobilized on ITO electrode by both CV and SOWG spectroscopy.

Experimental Condition
The SOWG system was the same as that described previously.[1-3] A 50-mm thick glass plate was used as a SOWG, and the thickness of ITO films were about 20 nm. The cell length was about 10 mm and the surface area of ITO-SOWG covered with sample solution was about 1.0 cm². In electrochemical measurements, the ITO electrode potential was controlled with a potentiostat (PAR Model 273A). The counter and reference electrodes were Pt wire and Ag/AgCl, respectively. Horse heart cyt c was purchased from Sigma and used as received. The sample concentration of proteins was 20 mol/dm³, and the phosphate buffer was used as a solution (pH 7.2). ITO electrode was immersed in tetrahydrofuran (THF) solution including 1 mM of phosphonic acid compounds (purchased from Dojindo Molecular Technologies, INC., Japan) for 10 min, and washed in THF with ultrasonic washing for 3 min.

Results and Discussion
At first the CVs and SOWG spectra using bare ITO electrodes with respect to washing process shown in Fig. 1and Fig. 2. CV oxidation and reduction peak currents, and the absorbance in Soret band at 408 nm in SOWG absorption spectra gradually decreased, and were finally zero. These results clarified that all cyt c molecules were desorbed with continuous solution exchange as washing process in the SOWG cell.
Next as an example the results about 10-CDPA modified ITO electrode are shown. The cyt c sample solution was put on the electrochemical cell on the 10-CDPA modified ITO electrode surface. After reaching to the equilibrium absorbance intensity at the peak position of Soret band at 408 nm in SOWG spectra, the sample solution was exchanged to the PBS solution, and the surface immobilized cyt c was remained on the ITO surface. Exchanging solution in the cell to fresh one 100 times decreased 7 or 8 % of absorbance at 408 nm. With bare ITO electrode, just 3 time exchanging decreased the absorbance at 408 nm about 10 % or so, thus 10-CDPA much affected the immobilization of cyt c on the PBS.

The CV of cyt c immobilized on 10-CDPA modified ITO was shown in Figure 1. The peak potentials of reduction and oxidation reaction were about 0.031 and 0.048 V, respectively. The peak separation was smaller than those with the cyt c immobilized on bare ITO electrode, indicating the increase of the ET rate constant. SOWG spectra showed the repeated peak change on Soret band between 408 and 416 nm with electrode potential scan between -0.3 and 0.3 V. Additionally the effect of 10-CDPA modification on immobilizing cyt c was shown from the SOWG absorbance decrease with changing PBS solution. These results indicated that the adsorbed species were categorized to be 3 kinds of them. These results will be reported in the presentation.

References
Characterization of In-vitro Bioactivity film on Ti-39Nb-6Zr alloy Fabricated by Microarc Oxidation

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Ti-Nb-Zr alloys have high yield strength and low Young’s modulus close to bone for addition of Nb element, furthermore, the addition of Zr benefits the blood compatibility. As a result, Ti-Nb-Zr alloys have been developed as good bone graft materials. However, they have poor wear performance, which limits the service life and application potential.

Microarc oxidation (MAO) is an efficient method to form porous bioactive ceramic films on Ti alloys, and the MAO films have good adhesion strength, corrosion resistance and wear performance. Recently, the β-type titanium alloys with high content of alloying elements such as Ti-39Nb-6Zr have drawn a great attention for its biological prospect. In this work, The MAO film on Ti-39Nb-6Zr alloy was successfully prepared in alkaline solution. Its morphology and composition were characterized by SEM and EDS. The tribological and electrochemical behaviors of bare and coated alloys were evaluated in phosphate buffer saline (PBS). The results show that corrosion and wear resistance in RBS solution are significantly improved after MAO surface treatment. The wear mechanism of Ti-39Nb-6Zr alloy is the abrasive wear and that of MAO coating is adhesive and fatigue wear. In addition, the MAO film has higher zeta potential at pH 7.4, which results in a higher protein adsorption amount. The biocompatibility was evaluated by culturing osteoblast cells on the bare and coated alloy. The MAO film shows a good cell adhesion and promotes osteoblast cell proliferation and differentiation into the polygonal shape due to its pore structure and higher roughness. Hence, the MAO film of Ti-39Nb-6Zr alloy show excellent corrosion and wear resistance and osteogenic properties, which has a promising clinical application.
The improved corrosion resistance and fatigue properties of 2024 Al alloy treated by SMAT and MAO process

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In order to improve the corrosion resistance and fatigue properties of coated 2024 aluminum alloy by microarc oxidation (MAO) method, a duplex process was designed to modify the alloy surface using surface mechanical attrition treatment (SMAT) prior to MAO. Experimental results show that surface grain size of Al alloy was refined to 52.8nm after SMAT with ZrO$_2$ ceramic balls for 15min. A 20μm thick nanocrystalline layer, with gradient changing grain size from dozens of nm in the surface to 200~500nm deep into the substrate, was successfully achieved on alloy surface. The microarc oxidation ceramic coatings with 5μm, 10μm and 15μm thickness grew by consuming part of the 20μm thick nanocrystalline layer. A SMAT-MAO duplex modified layer, which consists of an outer ceramic coating and an inner nanocrystalline layer, was formed on the surface of 2024 Al alloy. The fatigue life of duplex modified Al alloy increased by 21.8% and 23.2%, respectively, compared with single MAO treated alloy with the same coating thickness of 5μm and 10μm. The corrosion resistance of the MAO coated alloy decreased gradually, while that of SMAT-MAO coated alloy decreased in the initial state, then increased. Due to the formation of the dense passive film, SMAT coated alloy showed a more stable and improved corrosion resistance compared with that of simple MAO coated one.
Applications of Pack Cementation-based and Plasma-based Surface Treatment and Modification Technologies on Engineering Alloys

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Surface treatment and modification technologies have been widely studied and applied in almost all kinds of industries and biomedical field. Among these surface treatment technologies, the pack cementation-based chromizing and aluminizing processes are frequently used to enhance the high temperature oxidation resistance of superalloys. Meanwhile, the plasma-based physical vapor deposition (PVD) technologies can effectively improve the property and performance of cutting tools, molding dies and surgical instruments. In this study, the research work of the pack aluminizing processes on the Ni and Co based superalloys to prolong their service life at high temperature and the pack chromizing treatment on steels for improving their mechanical properties will be introduced. The plasma-based high power impulse magnetron sputtering (HiPIMS) technique to grow transition metal nitride hard coatings at a higher deposition speed is also discussed. In addition, the plasma-based wet process, plasma electrolytic oxidation on Ti, Mg and Zr alloys to improve their mechanical, corrosion and biocompatibility is explored. We can conclude that the performance and lifetime of engineering alloys can be effectively improved by selecting a proper pack cementation-based or plasma-based surface treatment and modification technology.

Biofilms and Surface Finishing

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Biofilms are formed on materials or tissues by bacterial activities. In environments within our human bodies, they are related to infectious and chronic diseases seriously. In those outside bodies, they are observed as sticky matters which might produce many industrial problems i.e. corrosion, scale problems, deteriorated heat exchange function, hygiene problems etc. Since biofilms are formed at the interface between liquid and solid phase, or between liquid and gas phases, surface engineering could play an important role to control biofilms from the industrial viewpoints. In this talk, we will mention concrete examples of industrial problems produced by biofilms and introduce some countermeasures from the viewpoint of surface finishing to control biofilms and to solve industrial problems.
Applications of Silver Electroplating Method for Enhancement of the Electrical Properties of Silver and Copper Nanowires

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We developed an electrochemical welding method for silver nanowires (AgNWs) and copper nanowires (CuNWs) by electroplating method with galvanostatic mode. The electrochemical welding was performed by immersing the as-coated AgNW film and CuNW film into cyanide-free silver solution and then the electroplating was performed by controlling the current density and applied time. The resulting materials after electroplating were compared with pristine material by measuring the sheet resistance and transmittance. Also, SEM and TEM were conducted to confirm the change of surface and cross-sectional morphology. The electrochemical welding reduced the resistances of AgNW and CuNW, and produced the transparency exceeding a certain level that can be used as TCEs. However, depending on the current density and applied time, the resistance decrease and the transmittance also decrease. Therefore, it is necessary to apply an appropriate current density and time for electrochemical welding of AgNW and CuNW. This simple, large-scale electrochemical welding technique provides an innovative approach to prepare transparent electrodes for use in next-generation flexible optoelectronic devices.
Nature Inspired Anti-stain Surface Treatment for Housing Wet Area

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1. Introduction
The fundamental way of thinking on the human and the earth conscious manufacturing and some examples of its application were discussed. One of the biggest suffering at home is a cleaning around the bath room area where water is used. Much energy and resources are consumed for eliminating dirt or stain at home as well as buildings. Anti-stain surface treatments mimicking snail shell are applied to housing wet area, resulting in the decrease of the housekeeping energy. In this paper, ceramic tile and sanitary ware are reported.

2. Snail shell and ceramic tile
The shell of snail is always clean on rainy days. Because many small grooves on the surface of the shell play a role like a rain gutter, the water film forms on the shell surface to prevent oily dirt. The dirt easily comes off with a little rain. Although ceramic tiles are originally hard to get dirty, it is necessary to be more hydrophilic than ordinary tiles for urban dirt including oil content like smoke. By coating with higher hydrophilic nanoparticles on ceramic tile (Fig. 1), the oil containing dirt is easily removed with rain alone.

3. Antibacterial sanitary ware
The antibacterial treatment is necessary to keep hygiene environment around wet area. Silver is widely used as inorganic antibacterial agents, because of high activity, broad antibacterial spectra, durability and low toxicity for human. Ag is applied to the sanitary ware glaze as an antibacterial agent. The glaze is amorphous aluminosilicate with 0.08 wt% Ag. The HEXRD (High-Energy XRD) results showed that the radial distribution functions of glaze were nearly identical with or without Ag. The XAFS (X-ray absorption fine structure) spectra of Ag-glaze were quite similar to that of AgNO₃ aqueous solution. This indicates that silver exist as monovalent cation in the glaze without forming crystal structure.

<table>
<thead>
<tr>
<th>Area</th>
<th>Stain</th>
<th>Surface Treatments</th>
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<tbody>
<tr>
<td>Kitchen</td>
<td>Oil</td>
<td>Hydrophilic treatment</td>
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<tr>
<td>Bath</td>
<td>Soap scum, Sebum</td>
<td>Hydrophilic treatment Anti-bacterial treatment</td>
</tr>
<tr>
<td>Toilet, Lavatory</td>
<td>Water stain</td>
<td>Si-capping</td>
</tr>
<tr>
<td>Outer Wall</td>
<td>Dust, Smoke, Soot Particulate matter</td>
<td>Hydrophilic treatment</td>
</tr>
</tbody>
</table>

Table 1. Anti-Stain surface treatments

Fig.1. SEM photo of hydrophilic coating on ceramic tile.
One-Process Fabrication of Nanoporous Sn-SnO$_2$-TiO$_2$/Cu$_6$Sn$_5$ Composite Films on Cu by Hybrid Electrodeposition for High Capacity Lithium-ion Battery Anodes

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Lithium-ion batteries (LIBs) have been widely used as power sources in many electric/electronic products such as cellular phones, digital cameras, portable computers, as well as electric vehicles (EVs) and hybrid electric vehicles (HEVs). To meet the ever-expanding needs for lithium-ion battery industry, it is highly desirable to explore new electrode materials with higher power density and satisfied lifetime cycles. As a promising candidate anode material for Li-ion batteries, Sn-based materials have attracted great attention for the replacement of the conventional carbonaceous due to its higher theoretical capacitance (Li$_4$Sn: 994 mAh g$^{-1}$) than graphite (LiC$_6$: 372 mAh g$^{-1}$) and the good electrical conductivity. However, Sn material delivers substantial volume changes during alloying/de-alloying process with Li, which usually causes the deterioration and peeling of the film electrode from the Cu electric collectors, thus resulting in rapid capacity fade and significantly affecting the cyclic lifetime of the batteries.

In this study, we propose a novel nanoporous Sn-SnO$_2$-TiO$_2$/Cu$_6$Sn$_5$ (SST/CS) composite film that directly electrodeposited on Cu sheets as binder-free and conductor-free anode material for LIBs. The nanoporous SST/CS composite films were fabricated on Cu sheets by a hybrid electroplating method, i.e., combining electro-deposition with electrophoric deposition. The morphology, chemical composition, chemical state, and crystalline structure of the electrodeposited films were investigated by FE-SEM, EDX, TEM (FIB), XRD, and XPS. Moreover, the charge-discharge performances of the SST/CS composite films on Cu were investigated at 0.01–2.0 V (vs. Li$^+$/Li) at 50–100 mA g$^{-1}$ and 303 K.

Fig. 1a shows the representative surface morphology of as-deposited Sn-TiO$_2$ composite films on Cu sheets. The composite film composed of nano-flakes crystals, thus making a nanoporous structure. The corresponding XRD pattern (Fig.1b) of a SST/CS composite film on Cu before and after annealing revealed formation of polycrystalline Sn, brookite TiO$_2$, and Cu$_6$Sn$_5$ intermetallic compound. EDX and XPS analysis disclosed that the as-deposited films consisted of Sn, SnO$_2$, and a small amount of TiO$_2$ in 1–10 at%. Moreover, galvanostatic charge/discharge tests (Fig.1c) revealed that the SST/CS composite films delivered a maximum value of 1227 mAh g$^{-1}$, and a high Coulombic efficiency above 90%, indicating a promising future as binder-free and conductor-free anode materials for LIBs.

Fig.1 (a) A surface FE-SEM image, (b) XRD patterns, and (c) galvanic charge/discharge curve of nanoporous Sn-SnO$_2$-TiO$_2$/Cu$_6$Sn$_5$ composite films on Cu sheets.
Effect of Anodizing Conditions on Porous Alumina Formation at Selected area with Solution Flow type Micro-Droplet Cell

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Porous alumina films formed by anodizing have been attracted much attention in recent years. The size and length of the pores are controlled by the anodizing conditions, such as voltage, temperature and composition of electrolytes. An area selective porous alumina film formation was achieved by lithography and laser techniques. These techniques, however, present disadvantage in the complex processes involved. A solution flow-type micro-droplet cell with co-axial dual capillary tubes (Sf-MDC) has been applied to simplify the formation processes and area selective formation of the films1,2). To apply the porous alumina for filters, accurate control of the film thickness and pore structure is required. It is, however, not fully elucidate the anodizing condition on structure of porous alumina films formed with Sf-MDC. The purpose of this experiment is the effect of anodizing condition such as substrate temperature on film structure of porous aluminum formed with Sf-MDC.

Highly aluminum sheets with 10 x 30 mm² and 110 μm thickness were used for specimens. The specimens were ultrasonically cleaned in highly purified water and in ethanol for 300 s each. The electropolising was carried out in 13.6 kmol m⁻³ CH₃COOH / 2.56 kmol m⁻³ HClO₄ at 28 V for 150 s at 278 K. The electropolished specimens were, then, cleaned with acetone and highly purified water. The electropolished specimen was set on the XYZ-stage, and the specimen temperature during the anodizing was controlled by a Peltier device between 293 K and 333 K. The solution for the anodizing was 0.22 kmol m⁻³ (COOH)₂. The used Sf-MDC was consisted of co-axial dual capillary tubes, the inside diameters of inner and outer capillary tubes were 100 μm and 200 μm. A Pt wire with 50 μm in diameter (counter electrode) was inserted into the inner capillary tube. A droplet of electrolyte was formed at the tip of the inner capillary tube, and then the droplet of electrolyte was put in contact with the specimen surface, and a constant voltage of 50 V was applied between the specimen and Pt wire. The moving speed of the specimen was controlled at 2.0 μm s⁻¹. The surface and cross section of the specimens were examined by optical microscope and SEM.

After anodizing, there were lighter line parts in the optical microscope images and the width of line part was about 370 μm independent of specimen temperature. No ordered pore was observed at 333 K. Fig. 1 shows surface SEM images after anodized at different temperature. Except for 303 K, a nano-size ordered pores are observed. These results suggest that between 313 K and 323 K are suitable substrate temperature for Sf-MDC anodizing.

References

![Fig. 1 SEM surface images of anodized specimen under 0.22 kmol m⁻³(COOH)₂ at different temperature.](image-url)
Modified Cyclic Voltammetry Stripping Analysis to Monitor Chemical Balance of Copper Electroplating Bath

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Accurate industrial sensor has been regarded as an essential part to facilitate the future smart factory, where all processes are monitored and automatically controlled. Cyclic voltammetry stripping (CVS) is one of the commercial industrial sensor to monitor the chemical balance of electroplating bath. This technique is particularly powerful when analyzing the rate-controlling organic additives (e.g. accelerator, suppressor, leveler), which are essential for void-free pattern-filling for copper damascene process. However, an accidental inclusion of organic and inorganic species into the plating bath, resulting from additive breakdown or cell corrosion, could lead to the significant error on CVS result. In this presentation, we will firstly review the current status of CVS as a monitoring tool for acid copper plating bath, which is applied for copper damascene process. A modified CVS algorithm that enables the analysis of SPS/MPS couple (brightener/brightener breakdown product) and molecular weight of PEG (suppressor) will be also discussed.
Highly flexible and transparent IWO electrode for OLEDs and perovskite solar cells

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We report the electrical, optical, mechanical, structural and morphological properties of high mobility W-doped In$_2$O$_3$ (IWO) films prepared by using a vertical type ion plating system on a PET substrate to replace the conventional sputtered ITO electrodes. Due to high ion energy input during ion plating process, the 100 nm-thick IWO film showed a sheet resistance ($R_{sh}$) of 36.39 Ohm/square and an optical transmittance (T) of 89.4% at 550 nm even though it was deposited at room temperature. Low sheet resistance of the ion-plated IWO film comparable to sputtered crystalline ITO film could be attributed to higher mobility (59 cm$^2$/V-s) of the ion-plated IWO films than that (32.5 cm$^2$/V-s) of sputtered ITO films. In particular, the ion-plated IWO film showed high optical transmittance in near IR wavelength region, which is beneficial of high mobility IWO electrode. Until outer bending radius of 6 mm and inner bending radius of 3mm, the ion-plated IWO film showed a constant a resistance change. In addition, dynamic outer and inner bending fatigue tests of the ion-plated IWO film showed no change in resistance ($\Delta R$) even after 10,000 bending cycles, demonstrating the flexibility of the ion-plated IWO film. To investigate the feasibility of the ion-plated IWO electrodes, we fabricated flexible perovskite solar cells on ion-plated IWO/PET and sputtered ITO/PET, respectively. Due to lower sheet resistance and higher optical transmittance of the ion-plated IWO electrode, the flexible CH$_3$CH$_3$PbI$_3$ perovskite solar cells with IWO anode showed higher power conversion efficiency of 8.964% than the sputtered ITO-based flexible perovskite solar cells (8.857 %). High PCE of flexible perovskite solar cells with ion-plated IWO anode indicates the possibility of the ion-plating IWO electrode as replacement of conventional sputtered ITO films for high performance flexible perovskite solar cells.

References
Reduction of odor from industrial material by using vegetable polyphenol and ozone water

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The water including ozone micro-nano bubbles water and vegetable polyphenol can be provided an environment friendly and improvement to many processes for industrial materials. Many applications of vegetable polyphenol water and ozone micro-nano bubbles water are studying for industrial processes in Kanto Gakuin University. As a problem in the production and use of automotive polymer composite parts, the total reduction of VOC (volatile organic compounds) which is given a bad influence on natural environments and human health are required. This problem should be solved by using of vegetable polyphenol and ozone micro-nano bubbles water.

The vegetable polyphenol is very safety and is having carbon neutral effect for natural environment. The polyphenol can be absorbed and reacted with bad chemical substance. As the result, the reacted substance should be become big molecule and harmless substance. The ratio of contact and reaction between ozone bubbles and treatment substance is good because a lot of small ozone bubbles are stayed for a long time in the water. And the ozone bubbles water produced tap water and oxygen in air, electric power without other resources.

It has been found that the applications of ozone micro-nano bubbles water and vegetable polyphenol water are effective for some car industrial processes. Some organic substances can be decomposed and absorbed, and the odor of old cotton clothes for car parts could be decreased by ozone micro-nano bubbles water and vegetable polyphenol water. Furthermore, the plastic surface can be washed efficiently, and the paintability of polypropylene car parts could be improved by ozone micro-nano bubbles water.
Copper-Cobalt Oxide Nanosheets Catalyst Array on Nickel Foam for Oxygen Evolution Reaction

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Development of non-noble metal catalyst for oxygen evolution reaction (OER) has become one of the most essential criteria for the commercial use of hydropower because the RuO$_2$ and IrO$_2$, ideal catalysts for OER, are scarce and expensive. Among the non-noble metal oxides, cobalt (III, IV) oxide has been received great attention due primarily to its high efficiency and low overpotential for OER. In this regard, the number of nano-sized cobalt oxide electrodes with different morphologies have been prepared and utilized as the anode of electrolytic water splitting system.

In this work, copper-cobalt oxides nanosheets catalyst layer was electrochemically prepared on the nickel foam substrate. Specifically, to achieve nano-porous morphology of deposit, cobalt oxide was co-deposited with copper oxide. The resulting cobalt-copper oxides nanosheet array showed significantly enhanced catalytic activity for the OER despite presence of nearly inactive copper oxide.

In this presentation, the catalytic activities of cobalt-copper oxides will be discussed in terms of electrochemical properties. In particular, several electrochemical parameters such as anodic tafel slopes and overpotentials at different current densities will be suggested and compared to that of other nanostructured catalysts reported in literature. Moreover, its activity to oxygen reduction reaction (ORR) will be presented to explore its potential as OER/ORR bifunctional catalyst in future work.
Optimization of Passivator and Corrosion Resistance of Cr-III based Conversion Coating on Hot-dip Zn55Al Coating

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Under the influence of environment and presence of moisture, hot-dipped galvanizing coating is easy to corrode, although galvanized steels have been used successfully for many years. In this paper, typical commercial trivalent chromium passivators, which are suitable for zinc alloy and aluminum alloy, have been selected. Based on the results of neutral salt spray test, the commercial passivator applied to the hot-dip coating is determined by orthogonal test. Then chromate conversion layers formed on hot-dip Zn55Al coating after suitable passivation treatment is investigated by means of SEM, EDX and XPS. The corrosion behavior of hop-dip steel samples subjected to Cr-III based passivation treatment is studied using electrochemical impedance spectroscopy measurements in 3.5% NaCl solution. Besides, the passivation process largely influence the neutral salt spray resistance of hot dip galvanizing, which seem to play an important role in the protection provided by the chromate conversion coating.
Effects of crystallographic texture and nano-scaled features on corrosion behaviors of electrodeposited zinc and their chromium passivation layers

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Thus far the influences of microstructure on corrosion behaviors of electrodeposited zinc coatings, which are widely used in industry, have rarely been studied. This study aims to establish a relationship between structure and corrosion behavior of electrodeposited zinc as well as their chromium passivation layers. Effects of crystallographic texture and nano-scaled features are systematically analyzed. Three types of alkaline non-cyanide based electrodeposited zinc coatings fabricated with different plating additives are investigated, using a series of complementary characterization techniques includes X-ray diffractometry (XRD), field emission scanning electron microscopy (FE-SEM), focused ion beam (FIB), and transmission electron microscopy (TEM). The corrosion behaviors of the coatings are then evaluated with the potentiodynamic polarization technique and salt spray test, in light of their structural characteristics, crystallographic texture, defects along the zinc/substrate interface and subsequently chromium passivation layer formation are identified.

Keywords: Galvanized coatings; Nanostructural features, Crystallographic texture, Chromate conversion coatings; Corrosion
Surface enhanced Raman Scattering (SERS) Substrates for Ultrasensitive Chemical Sensors

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The sensitive detection of chemicals and biomolecules is strongly demanded for the purposes of environmental monitoring, food safety, public security, personal healthcare and clinical diagnosis. Raman spectroscopic method is a useful technique, giving molecular finger-print information. Due to the low signal intensity, however, nanomaterials have been adopted to increase the Raman signals of bio or chemical species in trace level. The excitation of localized surface plasmon resonances (LSPR) on (or within) nanostructured metals provides the enhancement of Raman signal of molecules adsorbed on the materials, so called as the surface enhanced Raman spectroscopy (SERS). A series of scientific innovations based on nanotechnologies have stimulated a continuous expansion of the interest in SERS from theoretical understandings to practical applications. Over 4 decades from the discovery, the SERS research community continued to develop SERS materials and demonstrate their applicability in a variety of sensing applications. In this talk, I would like to review the progress of SERS materials and our recent achievements in fabrications of SERS-active substrates; closely-packed plasmonic nanopillars on a plastic film (KIMStrate) and Ag nanowire-based SERS filters. Both two kinds of SERS substrates are easily fabricated, reproducible and quite reliable for the practical applications. The sensitive detections of chemicals such as illicit drugs and explosives will be given to deliver a possible way of commercialization of SERS technology.
Photocatalysts as photo-functional materials are able to convert photo energy to chemical one, thus the property gives wide range applications for environmental cleaning and resource production, such as air and water purification, sterilization, hydrogen evolution, and photoelectrochemical conversion. In this presentation, new applications in biological field are reported.

1) **Production of rare sugars using photocatalysis.** Rare sugars have much attention because of their potential candidates for new foods and drugs. For example, D-Allose has strong suppressive effect against cancer cell proliferation. However, it is very hard to obtain those sugars, thus a common and facile new method to produce rare sugars is strongly requested. Our group recently reported that arabinose could be produced from the oxidative decomposition of glucose by titanium dioxide (TiO$_2$) photocatalysis under ultra-violet (UV) light illumination. In this work, we examined decomposition of monosaccharides to produce rare sugars by using the TiO$_2$ photocatalyst. Photocatalytic decomposition of galactose was performed with the TiO$_2$ photocatalyst under UV illumination, resulting in production of lyxose which is a rare sugar. We further performed photocatalytic oxidative decomposition of mannose, gulose, and allose, which allows production of arabinose, xylose and ribose, respectively. Those results suggested that photocatalytic oxidative decomposition is able to produce rare sugars.

2) **Spore inactivation with visible light responsive photocatalyst WO$_3$.** Bacteria that cause serious food poisoning are known to sporulate under conditions of nutrient and water shortage. The resulting spores have much greater resistance to common sterilization methods, such as heating at 100 °C and exposure to various chemical agents. Because such bacteria cannot be inactivated with typical alcohol disinfectants, peroxyacetic acid (PAA) often is used, but PAA is a harmful agent that can seriously damage human health. Furthermore, concentrated hydrogen peroxide, which is also dangerous, must be used to prepare PAA. Thus, the development of a facile and safe sporicidal disinfectant is strongly required. In this study, we have developed an innovative sporicidal disinfection method that employs the combination of an aqueous ethanol solution, visible light irradiation, and a photocatalyst. We successfully produced a sporicidal disinfectant one hundred times as effective as commercially available PAA, while also resolving the hazards and odor problems associated with PAA.

3) **Improvement of germination of seed using photocatalysis.** In seed germination, reactive oxygen species (ROS) play an important role. On the other hand, photocatalysts generate ROS under light illumination. In this work, we examined the effect of TiO$_2$ photocatalysis for the seed germination under light illumination. Germination rates of columbine, sunflower and crown daisy etc. after photocatalytic treatment were higher than those of control. Thus, the seed germination was improved using photocatalyst. Germination rate of seeds after absorption of diphenyleneiodonium chloride (DPI) as an inhibitor of germination was significantly decreased than that of control, whereas germination rate of both treatment of DPI and TiO$_2$ under UV illumination was increased than that of the only DPI treatment. DPI suppressed NADPH oxidase which makes superoxide anion in seed. Thus, these results indicated that superoxide anion is likely to improve seed germination.
Surface-Mediation of Aluminium Powders for Advanced Energetic Applications

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In this presentation, we report novel synthetic method and energetic properties of aluminum (Al) particles processed by surface fluorination in one-pot system. The surface-fluorinated Al particle shows that the poly(vinylidene fluoride) (PVDF) materials, used as chemical agent for fluoride reaction, directly contact with the surface of pure Al, instead of oxide layers formed by the spontaneous passivation. The STEM analysis on the PVDF coated-Al (PVDF/Al) powders indicates that the chemical bonding generated among Al, C, O and F atoms present in the PVDF layer with a 70 - 100 nm thickness uniformly coated on the Al surface. Here, we demonstrate that Al fluoride of complex compounds formed at the PVDF/Al interface plays an important role to prevent pure Al surface from re-oxidation but also to provide efficient oxidation path where the internal Al rapidly reacts with external oxygen atoms. Both thermal oxidation and combustion test show that the PVDF/Al powders have superior exothermic enthalpy energy and simultaneously a fast oxidation-reactivity due to vigorous pyrolytic process of surface-fluoride materials compared to the uncoated Al powders. These results elucidate that utilization of organic materials composed of hydro- and fluoro-carbon can be widely considered for improvement in physical properties of Al material.
In vivo study of microarc oxidation coated Mg stent to heal bone trauma defect

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Microarc oxidation (MAO) coated magnesium alloy with improved corrosion resistance have attract increasing interests in osseointegration application. However, the in vivo corrosion degradation behavior of the MAO coatings and the surrounding bone healing response is not well understood, which is highly required in clinic. Moreover, the interface between biodegradable magnesium implant and surrounding tissues is dynamic owing to the in vivo corrosion of magnesium, which makes the issue more complicated. In the present study, 10 μm and 20 μm MAO coated magnesium samples and uncoated bare magnesium samples were implanted into the New Zealand white rabbits employing a bone trauma defect model. The MAO coatings are mainly composed of MgO, MgSiO$_3$, Mg$_2$SiO$_4$, CaSiO$_3$ and Mg$_3$(PO$_4$)$_2$ phases. The blood test and histological test of animal heart and kidney indicated that no adverse effects were detected. The X-ray and μ-CT results revealed that abundant bone callus appeared in 8 weeks postoperatively of all the groups and the uncoated groups grew more, which is mainly due to the released Mg$^{2+}$ that promoting new bone formation. After 12 weeks, the bone trauma tended to cure and the bone callus of uncoated magnesium was more mature. The uncoated magnesium implant was completely dissolved in 8 weeks in vivo and the 20 μm thick MAO coated implant still existed in 12 weeks which showed excellent corrosion resistance. The results indicated that magnesium degradation and bone trauma healing promoting must be tailored by MAO coatings with different thickness for potential clinic application.

Key words: magnesium, microarc oxidation, corrosion, bone defect, in vivo degradation
First principles-base Computational Study on Creative Design of Key Materials for Renewable Energy Devices

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Innovative design of high functional materials in renewable energy systems plays a key role in powering transportation vehicles and portable electronics. This presentation introduces frontiers of research works by the first principles-based computational framework concerted on the purpose. As the example, nanoscale electro-catalysts in proton exchange membrane fuel cells (PEMFCs), Li-air batteries and solar cells for fuel generation are shown. It is clearly suggested that the method provide new design concept beyond conventional wisdom through the identification of fundamental descriptors and process mechanisms on and atomic level essentially leading to high efficiency of a whole system. The framework is potentially developed into a computational platform for the materials genome approach, which can substantially reduce the time period necessary from discovery to commercialization into markets of new materials.

References

1. S. H. Noh, M. H. Seo, J. Kang, T. Okajima, B. C. Han, T. Ohsaka, NPG Asia Mater, 8, e312 (2016)
Two-dimensional inhibitors and their anticorrosion properties in sol-gel coating on aluminum alloy

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Hybrid sol-gel coating is one of the most promising protective coatings to protect metallic substrates against corrosion. Traditionally, the coating acts as a passive barrier layer, protecting the metallic substrate from the attack of corrosive environments and water. However, various factors such as mechanical forces and temperature shock may lead to the degradation and the failure of the coating due to the formation and growth of defects (pores and cracks). Corrosive environments reach the metal surface and cause the corrosion of metallic substrates. It is necessary to impart active protection property to sol-gel coatings.

To achieve the active protection, we synthesized inhibitor nanocontainers with 2D structure, GO-supported LDHs (GO/LDHs) nanocomposites, by using graphene oxide (GO) and LDHs via a coprecipitation method. The corrosion inhibitors (vanadate anions and 2-mercaptobenzothiazole anions (MBT-)) were loaded into the GO/LDHs nanocontainers by an anion exchange reaction. The tests of pH responsive release and the bare AA2024 immersion were carried out to investigate the inhibitive property. GO/LDHs loaded with vanadate anions were added into sol-gel coatings applied on AA2024. The protective properties of the coatings were studied by electrochemical impedance spectroscopy (EIS) and salt spray tests.

The results of pH responsive release of inhibitors indicated that GO/LDHs were versatile enough to respond to both acid and alkaline conditions. The immersion tests of bare AA2024 displayed the Cl- responsive release of inhibitors from GO/LDHs-Inh- and the good corrosion inhibitive property of GO/LDHs-VOx-. A shiny bare AA2024 surface was still observed after immersion in 0.05 M NaCl solution with GO/LDHs-VOx- for 10 d.

The GO/LDHs-VOx- were added into sol-gel coatings applied on AA2024. It was found that the corrosion protection of the sol-gel coating was effectively enhanced. GO/LDHs-VOx- dispersed uniformly in the coating without causing any defects. No serious corrosion was observed on the alloy after 240 h of the salt spray test.
Synthesis of Ni Catalyst with CeO$_2$/La$_2$O$_3$ for Hydrogen Evolution in Alkali Solution

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In recent years, demands for hydrogen energy has increased rapidly, and development for a long stability, cheap and highly stable electrocatalyst is required. In this study, we report simple method to produce in commercial quantity nano-sized Ni catalyst with late transition metal for hydrogen evolution reaction (HER). CeO$_2$ and La$_2$O$_3$ were synthesized by co-precipitation on the carbon, and Ni was synthesized by solvothermal. They are simple method to manufacture a electrocatalyst has highly activity and durability more than commercial catalyst for HER. It was found that CeO$_2$/La$_2$O$_3$ play a key role to reduce size of Ni particle and serve to improve the characteristics of the inherent catalyst in a reducing atmosphere by forming solid solution with Ni.

**Keywords:** Ni catalyst, CeO$_2$/La$_2$O$_3$ particles, Nanostructures, Hydrogen evolution reaction
Flux Coating Innovation of Inorganic Crystal Layers for Next-Generation Energy and Environmental Applications

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Energy and environmental devices (and even materials) often consist of multicomponent with a number of interfaces and heterojunctions. In our laboratory, many kinds of high-quality, functional oxide, oxynitride and nitride crystals are successfully grown by flux method. Flux method, which is a liquid phase method, is one of the most versatile methods for obtaining well-developed crystals at low temperatures, with no thermal strains or defects from high-temperature solutions. Recently, our group has developed a novel flux concept “flux coating method”, in which high-quality crystal layers can be fabricated on various substrates. In addition, unique smooth interfaces can be fabricated via our flux coating technique. In this flux coating method, raw material pastes (or solutions) are coated onto substrates via various coating techniques, such as bar-coating, dip-coating, inkjet-printing and so on. The coated substrates are then heated to adequate temperatures and a large number of crystals can be directly grown onto the substrate surfaces (i.e., by buildup crystal growth). By heating the substrates, flux components melt, and then dissolve the solutes. As a result, crystals layers can be formed on various substrates via the concept of flux crystal growth. Our flux coating method has several advantages over the usual flux method. The most important advantage is that it is relatively easy to fabricate large-scale crystal layers on various substrates. In addition, flux-grown crystal layer conditions can be easily controlled by altering various growth (or coating) conditions. Therefore, our novel and unique flux coating technique has many industrial and ecological merits. Herein, we present a novel flux coating fabrication of various high-quality crystal layers and their smooth interfaces. In our flux coating fabrication, the crystal layers (e.g. LNMO, NMC, LCO, LLZO, LLNO and LTO as active materials and solid electrolytes for all-solid-state LIBs, and NaTaO\textsubscript{3}, Ta\textsubscript{3}N\textsubscript{5}, and BaTaO\textsubscript{2}N as UV-light-active and Vis-light-active photocatalysts, etc.) were directly grown on the various substrates. Details on the flux coating technique and inorganic crystal layers will be reported in “The International Symposium on Surface Treatment & Modification Technologies (STMT2017)”.

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Importance of Natural Oxide Film Control of Magnesium Plate

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In the case of magnesium and aluminum sheets, the natural oxide film is continuously generated due to the oxidizing property of the material. Many researchers have reported that after removing these surface oxides, the surface treatment reliability can be obtained when the conversion treatment is carried out. However, in the present study, it was observed that the surface cleaning process increased the oxide film of the magnesium plate. In order to secure the surface treatment reliability of the magnesium plate, good corrosion resistance can be obtained as the reaction with the chemical substance is minimized. In this study, the change of natural oxide film according to the type of acid was observed, and the corrosion resistance of the salt spray test was confirmed. For magnesium production, we will look at several examples of how important the control of natural oxide film is.
Development of high hardness and wear resistance composite coatings

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Hard coatings are used to improve the durability of products, cutting tools and anti-abrasive parts are coated with hard materials such as diamond and TiN by dry process. However, it requires specialized and costly equipment, extreme reaction conditions, and precise control of gas flow. On the other hand, wet process could be carried out under mild conditions and involves low-cost technology, but the content of particles incorporated into a coating may fundamentally affect its properties. While deposition coatings created using traditional co-deposition techniques have relatively low particles content. In this talk, we present some typical composite coatings developed by our group.

1. Ni-W/diamond composite coatings were prepared by sediment co-electrodeposition from Ni-W plating bath containing suspended diamond particles. This study indicates that higher diamond contents could be successfully co-deposited and uniformly distributed in the Ni-W alloy matrix. The maximum hardness of Ni-W/diamond composite coatings is about 2249 Hv due to the highest diamond content of 64 wt.%. The hardness could be further enhanced up to 2647 Hv at 873 K for 1 h in Ar gas, which is comparable to hard coatings prepared by dry processes.

2. Pulse current plating is an established method of electrodeposition metals and alloys, and it significantly affects the mechanism of metal crystallization. The technique usually yields homogeneous coatings with fine crystallite size, uniform morphology and limited amounts of defects. But to the knowledge of the authors no work concerning the application of pulse current plating for fabrication of Ni-W-diamond composite coatings has been reported. Herein, we report the Ni-W-diamond composite coatings prepared under pulse current electrodeposition, and the microstructure and microhardness of coatings were investigated as well. It is found that the pulse current can affect the rate of diamond incorporation and the content of tungsten alloyed in the matrix. The effect of the duty cycle and frequency on the hardness of the coatings is associated with the amount of diamond particles and the tungsten contents in the Ni-W matrix. Moreover, the diamond content is the primary mechanism in improving the hardness of composite coatings.

3. Hard nickel-tungsten-boron (Ni-W/B) nanocomposite, Ni-W-B alloy, and Ni-W-B/B nanocomposite coatings were designed and successfully prepared on the surface of low carbon steel by direct current electrodeposition. The fabrication parameters (e.g., boron source, boron particles concentration and current density) have been optimized. The effect of electrodeposition, crystallographic structure, surface morphology, heat treatment on the coatings was studied by XRD, SEM, hardness tester, and wear resistance. The results showed that the structure of the alloy was greatly affected by the boron particles. Furthermore, the electrodeposition parameters strongly affected the boron contents in the composite coatings. Moreover, the effect of thermal treatment on composite coatings hardness of the electrodeposited Ni-W/B, Ni-W-B, and Ni-W-B/B has been investigated; it indicated that the heat treatment could further improve the hardness of coatings.
Fabrication of nanostructures and functionalization on various polymer substrates using linear ion beam source

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In this talk, I’ll briefly introduce my research areas, especially, concerning the various applications using linear ion beam source. Considering conventional nanostructuring on flexible polymer substrates, it needs very high cost process such as lithography or transfer methods. In order to fabricate the nanostructures on polymer substrates, we have used a linear ion beam source of closed drift ion sources designed and assembled by ourselves. Linear ion beam source could be applied for roll to roll process or web treatment system using polymer films. Ion beam irradiations cause crosslinking and/or scission resulting in self-organized nanostructures. And we can modulate the size and repeatability by change of the irradiation conditions such as angle, energy, dose and species. Nanostructured and functionalized surfaces of flexible polymers could be applied for enhancing optical transparency, electrode adhesion and anti-fouling of flexible devices.
Surface modification of carbon materials

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Carbon materials such as Carbon nanotubes (CNTs), Graphene, and Graphene oxide are promising materials for electronic devices, structural materials, electrodes in batteries, and support for catalysts in fuel cells. In application, the surface states of carbon materials are important. The surface state of the carbon materials greatly change the properties of the materials itself and greatly influence the process and application characteristics. For example, the non-uniformity of films deteriorates their electronic properties and mechanical characteristics, and it originates from the wrong dispersion of CNTs in the suspensions used for the processing. Conventional pristine CNTs easily aggregate in aqueous solutions owing to their hydrophobicity.

As a method for changing the surface state of the carbon materials, there are a method of changing the surface state by physical adsorption such as a surfactant or a method of imparting a functional group by a chemical method. Since the method by physical adsorption with a surfactant is a simple method, it is often used for dispersing carbon materials such as carbon nanotubes in a solution. On the other hand, in order to cover the whole surface with a dispersant, a large amount of dispersant is required, causing a decrease in physical properties. Various methods for chemically changing the surface state of the carbon materials have been proposed. For example, in order to improve the dispersibility of carbon nanotubes, a method of introducing a carboxyl group or a nitro group by treating with a large amount of acid is used. In addition, chemical species with high toxicity such as hydrazine are used for reduction of graphene oxide. In this way, in order to chemically modify the surface state of the carbon materials, reaction under severe conditions is necessary.

In this presentation, we propose a method by plasma in liquid that chemically change the surface condition of carbon materials. The plasma in liquid is a non-equilibrium plasma in the solution, and the reaction in solution can be promoted by the active species generated in the plasma field. By using plasma in liquid, it is possible to react under gentle conditions. We will report the introduction of carboxyl groups into carbon nanotubes, preparation of functionalized graphene by exfoliation of graphite, and reduction of graphene oxide by using plasma in liquid.

Fig. 1 Surface modification of CNTs.
High Performance Zinc Alloys

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Zinc is the essential material for the cathodic corrosion protection of steel. However, it is sacrificing itself too fast, and its voluminous corrosion products are disturbing in many applications. Thus, zinc alloys are widely used. One of the best performance zinc alloy is zinc/nickel, since many years now accepted to provide the highest corrosion protection against both base metal and coating corrosion. In addition, it is - for a zinc-containing material - fairly heat resistant and protects well against contact corrosion with most aluminium alloys. Unfortunately, nickel is a substance of concern: intense contact with nickel ions causes allergies, and nickel aerosols as well as nickel-containing dust are considered as cancerogenic. In this light, other high performance alloys are increasingly of interest. One option is zinc/iron with elevated iron content, and this paper discusses their properties and performance, which seems to be an interesting alternative from the technical point of view, but also from the commercial aspect, since nickel cost are much higher than the cost for iron.

Achieving High Performance Ambipolar MoS₂ One-Dimensional Electrical Contact FET Through Plasma Etching

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Two dimensional semiconductors, like MoS₂, is promising as future nano-electronics which has good electrical, potical and mechanical performance. However, intrinsic MoS₂ only shows n-type electrical behavior which is suffering from Fermi level pinning effect. Metal induced gap states, sulphur defects or charged impurities in MoS₂ are all potential sources of n-type Fermi level pinning. Here, we present complementary MoS₂ FETs using multilayer MoS₂/metal one-dimensional (1D) contact via controllable plasma etching. An intrinsic multilayer MoS₂/Pd(high workfunction metal) 1D contact FET fabricated in this study shows ambipolar behavior with a record high average two-probe field-effect hole mobility as around 300 cm²V⁻¹s⁻¹. When temperature was lowered to 9 K, it was found that its two-probe field-effect hole mobility is still high at 381 cm²V⁻¹s⁻¹ from the same sample. While, with low workfunction metal Mo, an intrinsic MoS₂/Mo 1D contact FET fabricated shows n-type behavior. With the use of this MoS₂/metal 1D contact, we successfully demonstrate an inverter formed on intrinsic MoS₂, whose gain is ~ 14.7 at VSD = 5 V.
Electrochemical Plating of Cu-Sn Alloy in Non-cyanide Solution Using Tetrakis-(2-hydroxypropyl)-ethylenediamine as Complexing Agent

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Nickel (Ni) is typically used as an adhesive interlayer under the outmost coating layer because of its bright-white surface, good adhesion, high corrosion resistance, cheap and easy to deposit. It is used as base plating in jewelry, portable devices, and automobile components. However, if the outmost coating layer is corroded, Ni layer can be leached which causes to allergies, skin irritation upon contact with human skin or sweat. Therefore, the usage of Ni and its alloys is limited and strictly regulated in European countries. The plating of ternary alloy Cu-Sn-Zn has been commercialized and used this plating layer to substitute for the Ni undercoating layer, but this plating process used plating solutions containing cyanide ions (CN\textsuperscript{-}), which is now restricted to use by environmental regulation because of their high toxicity. Thus, the objective of this study is to develop a Cu-Sn plating solution that satisfies both Ni free and environmentally friendly cyanide free. The Cu-Sn speculum alloy obtained from this plating solution exhibited the bright-white color which is similar to that of nickel plated film and also it has excellent corrosion resistance. Furthermore, in this study, a mass production system of Cu-Sn plating was constructed by the optimization of management method and plating process.
Solution plasma treatment of TiO$_2$ materials for enhancing the photocatalytic activities

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TiO$_2$ has been widely investigated as photocatalyst because of its environmentally and economically advantages with high chemical stability, earth abundant and bio compatible properties. However, its large band-gap for the activity to only UV light region, and the high recombination rate of photogenerated electron and hole pairs have to be overcome to utilize effectively sunlight, and to enhance the photocatalytic performance. Recent enormous efforts to overcome the above-mentioned drawbacks have resulted in the one-dimensional TiO$_2$ nanotubes, nanofibers and nanorods to suppress the carrier recombination, and/or the heterojunction structure of TiO$_2$ with another semiconductor to achieve larger separation of the photogenerated electron and hole, as well as the modification of TiO$_2$ nanoparticles with gold clusters to expand the light conversion from UV to visible and near-infrared region. Another interesting approach on black TiO$_2$ nanoparticles succeeded in narrowing the band gap of pure white TiO$_2$ nanoparticles, however, it required the hard treatment condition of a 2 MPa hydrogen atmosphere at ca. 200 °C for 5 days. In order to synthesize the hydrogenated TiO$_2$ nanoparticles, the thermal treatment under hydrogen and plasma treatment have mostly relied on the reduction of TiO$_2$ nanoparticles. But, these processes have drawbacks such as high temperature over 1,000 °C, vacuum system for hydrogen plasma and long treatment time. After thermal treatment, the sintered nanoparticles should be crush to follow multistep processes. Thus, alternative approaches have been highly demanded in the reduction of TiO$_2$ with keeping its nano-sized particle. The in-liquid plasma processing, which is named as solution plasma and its schematic diagram is shown in Figure 1, is a non-thermal plasma discharged in liquid for synthesizing catalytic nanoparticles and preparing low molecular weight polymers. The present study focused to treat pristine TiO$_2$ nanoparticles by the discharge in water-based solution and to investigate the material properties as well as the photocatalytic activities for decomposing organics.

Fig1. Illustration of solution plasma for treating TiO$_2$ nanoparticles.
Improvement of sensing performance using Cu$_x$O/SnO$_2$ nanocomposites toward H$_2$S gas at Room Temperature

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Among various sensing materials toward H$_2$S, the copper oxide (Cu$_x$O)/tin oxide (SnO$_2$) composites have extraordinary sensing characteristics due to high response at room temperature. However, bulk Cu$_x$O/SnO$_2$ based gas sensors have that the slow response/recovery time in the range of 10 min and 3 hr, respectively due to the limited penetration of H$_2$S molecules into the interior regions of the bulk. Therefore, typical chemical sensor using bulk Cu$_x$O/SnO$_2$ materials cannot resolve these problems.

In this study, a facile spray method with annealing process was adopted to synthesize Cu$_x$O nanoparticles on SnO$_2$ nanorode between gold electrodes for an H$_2$S gas sensing material. TEM, XRD and XPS analysis were adopted to characterize the structure and composition of Cu$_x$O/SnO$_2$ nanocomposites. The sensors using Cu$_x$O/SnO$_2$ nanocomposites showed the response/recovery time in the range of 21 sec and 204 sec to 5 ppm H$_2$S, respectively, as well as high response similar as the previous sensors. These characteristics might be attributed to shorter diffusion paths of the interacting gas molecule as well as possessing a large surface area.
Development of Cr coating to prevent FCCI (Fuel-Cladding Chemical Interaction)

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A sodium cooled fast reactor (SFR) is a reactor operated to enhance the utilization of uranium resources. The SFR has many features designed to exceed safety requirements, and the SFR development is now in progress because of its sustainability, safety, economical advantage, and proliferation resistance. A metal fuel has superior thermal conductivity and, proliferation resistance in connection with pyroprocessing. Because of this, metal fuel has been selected as a candidate fuel in the SFR. But metal fuel suffers from a eutectic reaction with the fuel cladding (FCCI) at the reactor operation temperature. In order to prevent FCCI, the concept of a barrier is a necessary for provision of the safety cladding between the fuel and the cladding.

Chrome electroplating has been considered for the barrier tube because of its simplicity, superior resistance, strong ability with substrate, and effective coating performance. Cr coating was successfully carried out at the inner surface of HT9 tube cladding having 6.4 inner diameter and 7.4 outer diameter. As a result, a 20\textmu m layer of Cr was plated inside the tube surface. However microcracks generated during electroplating reduces the SFR performance. In order to reduce the microcracks, control of the electroplating parameters such as bath temperature, current density, duty cycle and plasma nitriding has been studied.

A 20\textmu m Cr layer as a barrier is investigated to simulate the chemical interaction between metal fuel and cladding. SEM and XRD techniques were used to characterize the Cr surface microstructure and chemical composition. To evaluate the Cr coating on the surface of the cladding, a diffusion couple test at 660\textdegree C for 25hours was carried out.
Electrolyte/Electrode Interface Engineering Toward Advanced Lithium-ion Batteries

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Lithium ion batteries (LIBs) are one of the most promising energy storage devices because of their high power and energy densities. LIBs have been successfully commercialized, the enhancement in their energy density is further necessary to satisfy modern society needs for application such as electric vehicles, power tools, and the efficient use of renewable energies. High energy density in a LIB can be attained by increasing the reversible capacity, the working potential, and tap density of the electrodes. Among various high-voltage cathode materials, high-nickel layered NCM, NCA and high voltage spinel LiNi\textsubscript{0.5}Mn\textsubscript{1.5}O\textsubscript{4} (LNMO) has been studied as promising cathode active materials for high energy density, however the practical application of these materials in LIBs is still quite challenging because those materials suffer from the severe oxidative decomposition of electrolyte beyond the upper voltage limit of LiPF\textsubscript{6}-based conventional electrolytes, around 4.3V vs Li\textsuperscript{+}/Li. This leads to uncontrollable SEI formation which results large irreversible capacity and capacity fading. Furthermore, sufficient ionic and electronic conduction path will tend to loss as increasing tap density of electrode, leading to impedance growth.

In this presentation, we will report our current progress on electrolyte/electrode interface engineering toward the achievement of both high voltage and high tap density electrodes for advanced LIBs, including three topics; 1) sub-2 nm thick fluoroalkylsilane self-assembled monolayer-coating\textsuperscript{1}, 2) Nb\textsubscript{2}O\textsubscript{5} nanosheet coating\textsuperscript{2}, 3) surface mixed anionization effects of cathode materials crystals\textsuperscript{3} for the enhancement of high voltage durability, and 4) three-dimensional electric micro-grid network for the enhancement of tap density through the reduction of conductive carbon loading and binder-free\textsuperscript{4}.

References
[2] “High-voltage capabilities of ultra-thin Nb\textsubscript{2}O\textsubscript{5} nanosheet coated LiNi\textsubscript{1/3}Co\textsubscript{1/3}Mn\textsubscript{1/3}O\textsubscript{2} cathodes”, S. Uchida, N. Zettsu, K. Hirata, K. Kami, K. Teshima, RSC Advances, 6 (2016), 67514-67519.

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**Study on alternative electroplating processes for reducing gold usage in electrical connector**

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Gold alloy electroplating techniques have been widely used for manufacturing electrical connectors, because electrodeposited gold alloys have excellent solderability, and stable contact and corrosion resistances. Recently, due to the steep increase in gold prices, a number of processes that use alternatives for gold, and gold plating processes that use other alloy elements, have been proposed by many researchers to reduce the usage of gold. In this study, 1) gold-silver alloy electroplating processes, 2) current efficiency-controllable gold plating methods, and 3) ammonia-free palladium-nickel alloy plating methods will be presented for the reduction of gold usage. Furthermore, the possibility of gold alternatives or reduced-gold-usage processes will be discussed.

**Electro and Electroless Plating for the Electronics Industrial Applications**

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Electro and electroless plating have been used in many applications. These electrochemical processes were not frequently used in the electronic industry until 80's. However the electro and electroless plating have been used in the electronic industry after copper metallization was announced to replace aluminum lines in ULSI. Since then the more electro and electroless plating were studied and used in the electronic industry. In this presentation, the current electroplating of copper in the electronic devices, especially via filling, will be covered. The nickel and its alloy plating will be also introduced for the diffusion barrier and hard surface coating. Electroless plating of copper and nickel for the PCB and UBM applications is covered with its fundamentals. Other electroplating of metal and alloy will be mentioned.
Ni-based incorporation for superior corrosion properties by surface modification

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The present study investigated the incorporation of Ni-based compound on the surface of AZ31 Mg alloy via one-step plasma electrolytic oxidation (PEO) employing Ni(NO\textsubscript{3})\textsubscript{2}\cdot6\textsubscript{2}O in alkaline-based electrolyte at a current density and a frequency of 100 mAcm\textsuperscript{-2} and 60 Hz, respectively. The surface morphology, chemical composition, surface chemistry, and corrosion behavior of the coatings were observed using scanning electron microscopy (SEM), X-ray photoelectron spectroscopy (XPS), electron probe microanalyzer (EPMA), and potentiodynamic polarization test (PDP) in 3.5 wt.% NaCl solution, respectively. The coatings exhibited typical porous surface microstructure and sufficient coating thickness with uniform distribution of Ni element throughout the coating. PDP results showed that with incorporation of Ni-based compound led to different behavior in corrosion protection which could mainly attributed to the morphological characteristics of the coatings induced by the formation of fine plasma-discharges.

Keyword: Ni-based coating, plasma electrolytic oxidation, corrosion resistance
Poster Session
Evaluation on Sensitization of Stainless Steel 304 Steel by Artificial Aging and DL-EPR Test

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Austenitic stainless steel has been used in various power plant facilities and applied to the material of the structure, tube and components. These materials expose to high temperature during long-period. Therefore, corrosion resistance and mechanical property can be reduced by sensitization. It is the formation of chromium carbide and chromium depletion zone around grain boundary. Sensitized austenite stainless steel is very susceptible to corrosion attack and intergranular stress corrosion cracking. In this study, stainless 304 heat resistant steel was investigated after artificial aging at 650 °C for time up to 1,000 hours and then tried to evaluated degree of sensitization(DOS) by double-loop electrochemical potentiokinetic reactivation(DL-EPR) test. DL-EPR test was carried out in corrosion cell consisted of Ag/AgCl reference electrode and platinum counter electrode. H$_2$SO$_4$+KSCN solution was used as electrolyte. The temperature of solution was about 25°C. After DL-EPR test, the maximum current density in the forward scan loop(Ia) and the reverse scan loop(Ir) was measured. The DOS was evaluated as Ir/Ia. After the experiments, scanning electron microscope(SEM), EDS and three dimensions(3D) microscope were used to analyze damaged surface. The result revealed that the DOS and surface damage was increased with the aging time.

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Enhancement of Cavitation-Erosion Resistance in Marine Environment for Austenitic Stainless Steel by the DC Glow Discharge

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To improve wear and fatigue for austenitic stainless steel, plasma ion nitriding treatment has broadly been used due to the formation of solid solutions of N in \(\alpha\)-ferrite. Plasma ion nitriding process is a thermochemical surface modification treatment for austenitic stainless steels to enhance wear and fatigue properties by a formation of several solid solutions of N in \(\alpha\)-Fe such as \(\varepsilon\)-Fe\(_{2,3}\)N and \(\gamma\)'-Fe\(_{4}\)N.

A damage of cavitation-erosion is occurred by the impact pressure during bubble collapse or the micro-jet in a fluid and it even increases attacked by chloride especially in seawater. The plasma ion nitriding treatment was performed for austenitic stainless steels at temperatures of 350 to 500 °C, in order to evaluate the cavitation-erosion characteristics as temperature increasing. Plasma ion nitriding was carried out by a DC glow discharge method with a gas mixture of 25\% N\(_2\)+75\%H\(_2\) for 10 hr.

Cavitation-erosion test was carried out with a peak to peak amplitude of 30 \(\mu\)m at sea water temperature of 25 °C for 1 to 10 hr, complying with the ASTM G-32 Standard. It was maintained cavitation amplitude of 30 \(\mu\)m, seawater solution temperature of 25 °C. In addition, the stand-off distance from horn tip to sample surface was kept with 1 mm. The cavity was induced on the sample surface with exposed area of 4 cm\(^2\) by vibration generator, which utilized the piezoelectric effect with 20 kHz vibration rated output. The variation of nitride phase on the surface and micro hardness were analyzed with the increase of process temperature. The resistance of cavitation-erosion is closely involved with surface hardness. As increase of process temperature, micro hardness is increased due to the formation of nitride ferrite and chromium precipitation. After completion of the cavitation-erosion test, damage loss and weight loss were measured, in addition, surface morphologies were observed.

Relatively less surface damage and weight loss were found out at a temperature of 350 to 450 °C due to the increase of micro hardness, by the formation of S-phase. However, at a process temperature of 500 °C, surface damage and weight loss and damage depth were remarkably increased.
The Effect of Gaseous Nitriding Phases Controlled with Customized Lehrer Diagram of AISI 4140 to Enhance the Fatigue Resistance of the Steel

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In this study, gas nitriding is evaluated with the purpose of applying the customized Lehrer diagram of AISI 4140 and improving the fatigue resistance of the steel. Gas nitriding is an important thermochemical surface treatment that is used to improve the mechanical properties as well as the fatigue endurance of steels. Lehrer diagram of pure iron is widely used in industry to control the nitride phase using nitriding potential instead of Lehrer diagram of steels. However, nitride phases of the steels can’t be accurately controlled with Lehrer diagram of pure iron during gas nitriding. It leads to erroneous results for steels as elements, which are included in steels, form the different stability phases in steels during gas nitriding. Customized Lehrer diagram of AISI 4140 has calculated using the computational thermodynamic program to predict the relationship between the nitriding potential and the phase stability as a function of temperature. The customized Lehrer diagram of AISI 4140 is applied in the experiment and gas nitriding is carried out to form three different phases of $\varepsilon$-$\text{Fe}_2\text{N}, \gamma'$-$\text{Fe}_3\text{N}$ and the compound phase at fixed certain nitriding potential and temperature. The nitride phases controlled with the customized Lehrer diagram shows excellent agreement with theoretical and experimental results. The microstructure and nitrogen concentration of nitride layer have been examined via optical microscopy, FESEM, XRD, EBSD, GDS and EDS. Fatigue tests and hardness were carried out by rotary bending fatigue machine and micro-vickers hardness tester, respectively.
Microstructure and Oxidation Behavior of Nanostructured Ti–Si–B–C–N Films Deposited by Unbalanced Magnetron Sputtering

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Nanostructured Ti–Si–B–C–N nanocomposite thin films were deposited on AISI 304 stainless steel substrates by d.c. unbalanced magnetron sputtering from a TiB2–TiC compound target and a pure Si target. The relationship between microstructure and oxidation behavior of the films was investigated in terms of the nanosized crystallites/amorphous system. The synthesized Ti–Si–B–C–N films were characterized using x-ray diffraction (XRD), x-ray photoelectron spectroscopy (XPS), atomic force microscopy (AFM), and high resolution transmission electron microscopy (HR-TEM). From our microstructural analyses, it was revealed that the Ti–Si–B–C–N films were nanocomposites composed of nanosized TiB2, TiC, and TiSi2 crystallites (2–3 nm in size) embedded in an amorphous matrix. The dynamic oxidation was investigated using a thermal analyzer with differential scanning calorimetry and thermogravimetric analysis in flowing air atmosphere. The conventional oxidation resistance analysis was also performed in air using conventional furnace on the samples deposited on AISI 304 stainless steel substrate. The samples were annealed in the furnace from room temperature to 1000 °C for two hours. And then, the annealed samples were characterized using XRD and radio-frequency glow discharge optical emission spectroscopy (RF-GDOES). Based on our results, it was concluded that the addition of Si into the Ti–Si–B–C–N film improved the mechanical properties and oxidation resistance of the Ti–Si–B–C–N films. The improvements are due to the formation of an amorphous SiOx phase, which plays a major role in the oxidation barrier on the film surface. This study clearly demonstrates that the Si-doped Ti–B–C–N coatings can be applied to protect the dry cutting tools as well as to prolong the life time die casting molds under high temperature applications.
Mechanical and Tribological Properties of Ti–Si–B–C–N Nanocomposite Coatings Deposited by Pulsed Unbalanced Magnetron Sputtering

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Ti–Si–B–C–N nanocomposite films were prepared onto AISI 304 stainless steel substrates with various nitrogen and silicon contents using a pulsed d.c. magnetron sputtering system from a TiB\textsubscript{2}–TiC composite target in an argon–nitrogen atmosphere. The quinary Ti–Si–B–C–N (5 at.\%) film showed excellent mechanical, tribological and wear properties compared with those of the Ti–B–C and Ti–B–C–N films. Based on our results, it was revealed that the Ti–Si–B–C–N films were nanocomposites composed of nanosized TiB\textsubscript{2}, TiC, and TiSi\textsubscript{2} crystallites (2–3 nm in size) embedded in an amorphous matrix. The addition of Si to the Ti–B–C–N film led to precipitation of nanosized crystalline TiSi\textsubscript{2} and percolation of amorphous SiC phases. The Ti–Si–B–C–N films with up to 7 at.% Si content presented high hardness (~35 GPa), H/E (~0.0095), and $W_e$ (>50%) with compressive residual stress (~0.5 GPa). Such a combination of mechanical properties can be indicated the considerable potential of this film for applications in mechanical components. It was also concluded that the addition of Si to the Ti–B–C–N film led to an improvement of the tribological properties (COF $≈$ 0.151 and wear rate $≈$ 2 $\times$ 10\textsuperscript{−6} mm\textsuperscript{3}N\textsuperscript{−1}m\textsuperscript{−1} of the Ti–Si–B–C–N films. The improvements are due to the formation of an amorphous SiO\textsubscript{x} phase, which plays a major role in the self-lubricant tribo-layers on the film surface or in the grain boundaries.
Effect of plasma treatment on surface properties of 2D tungsten diselenide

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Two dimensional (2D) materials are expected to be used for future wearable and transparent device applications due to their sizable band gap in the range of 0 to 2eV, as well as high flexibility and transparency. Among 2D materials, tungsten diselenide (WSe$_2$) can be prepared to form atomically ultrathin film and it has been actively studied as a next-generation semiconductor material which shows band gap of ~1.3eV and non-degrading performance in the air. Plasma has been frequently used for the purpose of changing surface states of semiconductor materials because of the advantages enabling room temperature and large scale processes.

In this study, we carried out plasma treatments using various processing gases (Ar, O$_2$, SF$_6$, N$_2$) and observed corresponding changes in etching rate, surface morphology and surface charge state. Atomic force microscopy (AFM) and Kelvin probe force microscopy (KPFM) were used for quantitative analysis on the effects of plasma treatment. We could observe a strong n-type shift by introducing fluorine ions and decreasing work function to 0.7eV upon SF$_6$ plasma treatment while we could observe a p-type shift by introducing nitrogen ions and increasing work function to 0.4eV. As a result, this research demonstrates that single gas plasma treatments can give rise to interesting results and can show effects similar to doping.

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Characteristics of BDD electrodes deposited on Ti substrate with TiNx interlayer

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Recently, a great quantity of various wastewater was discharged due to a development of industry. In order to treatment of wastewater, the research on electrochemical wastewater treatment is actively in progress. The electrochemical wastewater treatment can be treat for various pollutant economically and efficiently using the oxidation process without addition of oxidizing agent. Among them, BDD electrodes exhibits excellent water treatment properties due to a high generate hydroxyl radical on the surface. So, much research about BDD electrodes is underway in the field of water treatment electrodes. Nb, which is the original substrate of BDD electrodes, has long lifetime and good water treatment ability. \cite{1,2} Despite the advantages of Nb, it is difficult to wide utilize for water treatment because of high price. So, we replace the substrate material from Nb to Ti. Ti is suitable for substrate of BDD electrodes because of high mechanical strength, electrochemical stability. Especially, Ti is cheaper than Nb. But Ti substrate has several problems. First, a high residual stress based on lattice mismatch between Ti and BDD. Second, at high temperature for BDD deposition, TiC layer is formed by diffusion carbon into the Ti substrate. It is lead to decrease adhesion between Ti and BDD. In order to solve these problems, we will insert a TiN interlayer. The crystal structure of TiN is similar to BDD and used for diffusion barrier layer of several metal coating due to a high melting point, high chemical stability and good electrical properties. As inserting TiN interlayer between Ti and BDD, it could be control the formation of TiC layer, reduce a residual stress based on lattice mismatch and increase adhesion of BDD layer. Also pre-treatment of substrate is influence crystal growth and microstructure of BDD thin films. Accordingly, this process is influence electrochemical performance of BDD electrodes. Therefore, prior to deposition, pre-treatment of substrate should be optimized to obtain the high efficient BDD electrodes.

In this study, the BDD films were deposited on TiN/Ti thin films by HFCVD. TiN interlayer was deposited on pre-treated Ti substrate by DC magnetron sputtering. Ti substrates were sandblasted, etched in HCl, and then seeded in diamond suspension. Purpose of this process is improving adhesion of BDD electrodes by forming micro-roughness and is control the diamond nucleation density. \cite{3} The details of this study will be discussed at the conference.
The Influence of Natural Oxide Layer of Strain-hardened Austenitic stainless steel on the Low-Temperature Acetylene Based Vacuum Carburizing Process

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In this study, we investigated the cause of low-temperature vacuum carburizing efficiency depending on the degree of work hardening of austenitic stainless steels. Low-temperature vacuum carburization was performed on the strain hardened material with different heat treatment temperature, and the relationship between the carburizing efficiency and the natural oxide film and grain change was studied. We were found that the low-temperature vacuum carburizing efficiency of stainless steel is determined by the decomposition rate of the natural oxide film, which has the extremely low solubility of carbon. And the thickness and density of the natural oxide film are influenced by the strain-hardening process. Through the heat treatment process, it was possible to increase the carburizing efficiency by controlling the thickness and fraction of the natural oxide film by reducing the deformation structure and internal stress applied to the base material.
Reactive sputtered tin adhesion layer for wastewater treatment for bdd electrodes

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For several decades, industrial processes consume a huge amount of raw water for various objects that consequently results in the generation of large amounts of wastewater. These effluents are mainly treated by conventional technologies such as aerobic, anaerobic treatment, and chemical coagulation. But, these processes are not suitable for eliminating all hazardous chemical compounds from wastewater and generate a large amount of toxic sludge. Therefore, other processes have been studied and applied together with these techniques to enhance purification results. These techniques include photocatalysis, absorption, advanced oxidation processes, and ozonation, but also have their own drawbacks. In recent years, electrochemical techniques have received attention as wastewater treatment processes that show higher purification results and low toxic sludge. There are many kinds of electrode materials for electrochemical processes, among them, boron doped diamond (BDD) attracts attention due to good chemical and electrochemical stability, long lifetime, and wide potential window that necessary properties for anode electrode [1-3].

So, there are many researches about high quality BDD, among them, researches are focused on Si substrate [4]. But, Si substrate is hard to apply as electrode application due to the brittleness and low lifetime. And other substrates are also not suitable for wastewater treatment electrode due to high cost. To solve these problems, Ti has been candidate as substrate in consideration of cost and properties.

But there are critical issues about adhesion that must be overcome to apply Ti as substrate. In this study, to overcome this problem, TiN interlayer is introduced between BDD and Ti substrate. TiN has higher electrical and thermal conductivity, melting point, and similar crystalline structure with diamond. The TiN interlayer was deposited by reactive DC magnetron sputtering (DCMS) with thickness of 50 nm, 1 µm. The microstructure of BDD films with TiN interlayer were estimated by FE-SEM and XRD. There are no significant differences in surface grain size despite of various interlayer. In wastewater treatment results, the BDD electrode with TiN (50nm) showed the highest electrolysis speed at livestock wastewater treatment experiments. It is thought to be that TiN with thickness of 50 nm successfully suppressed formation of TiC that harmful to adhesion. And TiN with thickness of 1 µm cannot suppress TiC formation.

References
Carbon black and titanium interlayers between zinc oxide photoelectrode and FTO for dye-sensitized solar cells

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Dye-sensitized solar cell (DSSC) has attracted a great deal of attention as a good candidate for low-cost, low-energy consumption, high-glazing angle solar cells. In DSSC, working electrode roles pretty much in deciding the photovoltaic performance of the solar cell. Zinc oxide (ZnO) is a promising candidate for an alternative anode material; it has unique properties such as higher binding energy, high breakdown strength, cohesion, and exaction stability. The band gap energy 3.2 eV and conduction band edge of ZnO are very similar to those of TiO\textsubscript{2} that is the most prevailed photoelectrode material. In this context, the ZnO layer was deposited by plasma-enhance chemical vapor deposition (PECVD) and optimized the thickness, and then the carbon black and titanium films deposited by radio frequency (RF) magnetron sputtering with thicknesses of about 58, 60, and 120 nm was introduced between ZnO and fluorine-doped tin oxide (FTO) glass. The power conversion efficiency (PCE) of DSSCs with the 120nm thickness carbon black, titanium, and no interlayer were 5.21%, 4.45%, and 3.25% respectively. The PEC improvement with interlayers.
Electrochemical Corrosion resistance of aluminum-doped zinc oxide film depending on the hydrogen content

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Aluminum-doped zinc oxide (AZO) film is a promising transparent conducting electrode that can substitute for the commercially using indium tin oxide with its cheapness, safety to human body, easy supplying and chemical inertness. Especially, for the electrode of photovoltaic device such as copper indium gallium selenide (CIGS) solar cell that should endure in the atmospherically humidified environment, its corrosion resistance is very important. AZO is the n-type semiconducting material to which trivalent Al is doped in the divalent Zn. And the electric conductivity of the hexagonal wurtzite material is very dependent on the oxygen vacancies. Since the hydrogen in the AZO process influence a lot to the concentration of oxygen vacancy, many researches has been optimized the hydrogen content for the good electric conductivity. In this study, the hydrogen content was varied in the range of 0 ~ 10 \% during the radio frequency (RF) magnetron sputtering. The effect on the resistivity, optical transmittance and corrosion resistance was investigated. As the hydrogen increased, the resistivity decreased and increased with much hydrogen, and the optical transmittance did not show a valid difference with the variation of hydrogen. Corrosion resistance measured by using potentiostatic polarization test showed a dependence on the hydrogen content by changing the crystallinity, grain size and microstructure of the film. With lower hydrogen introduction, the columnar morphology with small grains in AZO film induced a bad corrosion resistance.
Silicon nitride encapsulation for OLED devices by very high frequency PECVD using a multi-split electrodes

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In this study, uniform and high-density plasmas without the standing wave effect could be formed for very high frequency (VHF) of 162 MHz by using a multi-split electrodes. In addition, by using the VHF-PECVD, a stoichiometric silicon nitride (Si$_3$N$_4$) with a high deposition rate (430 nm/min) and a high deposition uniformity (2.3%) could be deposited under the optimized process condition of 1500 mW/cm$^2$ of rf power, 200 mTorr of operating pressure, gas mixture ratios of 3/1 (NH$_3$/SiH$_4$), and at 80 °C of low substrate temperature. With this deposition condition, the deposited 430 nm thick SiNx film exhibited a high optical transmittance of 95% and a low WVTR of 4.47 × 10$^{-4}$ g (m$^2$ • day)$^{-1}$. Finally, when SiNx thin films were deposited on OLED devices and patterned samples, no electrical damage was observed on the OLED devices and and higher step coverage was observed on the patterned samples for the multi-tile push-pull VHF (162 MHz)-PECVD as compared with conventional PECVD operated at 13.56 MHz. It is believed that the thin film encapsulation technology of VHF (162 MHz)-PECVD using a multi-split electrodes can be applied not only to the Si$_3$N$_4$ thin film deposition for flexible organic electronic devices but also to the deposition of various next generation semiconductor materials by PECVD requiring high quality materials at high deposition rates.

Keywords: silicon nitride (Si$_3$N$_4$), very high frequency (VHF), multi-split electrodes, step coverage, organic light emitting diode (OLED)
Thick Tetrahedral Amorphous Carbon Films Prepared by Filtered Catholic Vacuum Arc Method

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High-quality Tetrahedral Amorphous Carbon Films (ta-C) can be prepared by the filtered cathodic vacuum arc (FCVA) method at room temperature, which are attracting materials because of their properties similar to diamond, such as extremely high hardness, low friction coefficient and excellent anti-corrosion property. However, it is difficult to form the thick ta-C films due to the high internal stress, which affects the properties of the films. At home and abroad, most of the thickness of the ta-C film is less than 1 μm. In this paper, the appropriate deposition parameters of the film are obtained, which effectively decreases the internal stress. The thick ta-C film was successfully fabricated on 304 stainless steel substrate with 48 μm by FCVA method. The structure and mechanical properties of the film were investigated by scanning electron microscopy (SEM), Raman spectroscope, HT-1000 ball-on-disk high-temperature friction and wear tester and electrochemical techniques. The results show that the ta-C film has a good adhesion strength substrate, high hardness and excellent resistance wear properties.
Study for Control of Microstructural Characteristics of Biomedical Ti-39Nb-6Zr-0.45Al Alloy

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Ti-39Nb-6Zr-0.45Al alloy was developed for biological applications as exchangeable hard tissue. This alloy has very low elastic modulus, but lower strength than Ti-6Al-4V alloy. This study was performed for improving the strength by various heat treatments and microstructural characteristics and mechanical properties of Ti-39Nb-6Zr-0.45Al alloy were investigated. Heat treatments were conducted at 350℃, 400℃, 450℃, 500℃, 550℃ and 600℃, followed by water quenching. Microstructures of Ti-39Nb-6Zr-0.45Al alloy showed two types of different features. One of the features was not visible for grains at low temperature heat conditions (350℃, 400℃ and 450℃), because of the effect of cold swaging. On the contrast, at high temperature conditions (500℃, 550℃ and 600℃), the grains were visible. Average hardness of low temperature conditions was higher or equal than the as-swaged condition. Tensile properties had similar tendency to hardness properties under all low temperature conditions. The samples showed high strength and low elongation under low temperatures, but showed the opposite results under high temperature conditions. These results were due to thermal ω phases and secondary α phases inside the matrix of this alloy. This phenomenon can be explained in relation with microstructural characteristics for all the conditions. ω phases, which were precipitated under low temperature heat treatments, induce high strength and low elongation. In case of high temperature conditions, ω phases disappeared into the matrix and secondary α phases with fine size appeared. Young’s moduli of the samples under all the conditions was lower (about 60GPa) than those of the as-swaged (about 70 GPa). Consequently, the heat-treated Ti-39Nb-6Zr-0.45Al alloy had high strength and very low elastic modulus, thus this alloy was suitable for biomedical applications with biological strong surface film.
Effect of Al Addition on Corrosion Protection of Ti-39Nb-6Zr Alloy for Biological Applications

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For metals to be used as biomaterials, there must not be harmful reaction between the corrosion product of metal or eluted ion, and bio-tissue. Titanium is one of the excellent bio-compatible materials and generally it has tendency to have a small amount elution of Ti ions inside the body. Titanium alloy need to have low elastic modulus for reducing the stress shield effect. Ti-39Nb-6Zr alloy which is consist of biocompatible element such as Nb and Zr, has very low elastic modulus with below 60GPa, but it shows lower yield stress and tensile stress compared with Ti-6Al-4V alloy. In order to increase the strength of Ti-39Nb-6Zr alloy, aluminum was added in this alloy. Since aluminum elements are reported to lead to Alzheimer disease in human, high corrosion resistance is required to use Ti-39Nb-6Zr+Al alloy containing a small amount of Al. Titanium implant parts are also to be easily revealed in fluorine environment such as dental parts. Corrosion of titanium material is apt to be accelerated in fluorine environment. In this study, corrosion behaviors were investigated under the solution of three conditions of 0.9% NaCl (pH 7), 0.1% NaF (pH 3) and 0.1% NaF (pH 5). As a result, the corrosion behaviors of Ti-39Nb-6Zr alloy showed no significant difference in 0.9% NaCl (pH 7) and 0.1% NaF (pH 5) solutions and in the case of Ti-39Nb-6Zr+Al alloy, there was no significant difference in the two solutions. Even under 0.1% NaF (pH 3) solution which is more severe environment than the other two solutions, it showed stable corrosion behaviors in the two alloys. The behaviors were stable under all the conditions. But Ti-39Nb-6Zr+Al alloy had better corrosion resistance than Ti-39Nb-6Zr alloy in all the conditions. This is because oxide mixtures such as Al₂O₃, Al₃Ti₅O₁₅, Al₅TiO₅ are formed inside the surface layer, which results in forming more stable oxide film than TiO₂ surface film. Ti-39Nb-6Zr+Al alloy has high corrosion resistance and can reduce the concern about aluminum ion elution inside the body.
SBF evaluation of HA precipitation on Ti-6Al-4V

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Ti-6Al-4V alloys are used in a variety of bone substitute applications, including orthopedics and implants. However, contact of bones with implants under in vivo conditions can lead to insufficient stability and dissolution of metal ions on the tissue adjacent to the implant. For this reason, proper surface deformation is very important to improve the biocompatibility of implants. A commonly used method of surface modification to improve the biocompatibility of dental metal implants is to form a hydroxyapatite [HA, Ca_{10}(PO_{4})_{6}(OH)_{2}] layer on the surface. The result is that the surface properties represent special in vivo processes that allow growth and modification in bone tissue.

This study investigated the formation of bone-like apatite after precipitation in electrolytes containing bioactive Si, Mn, Mg, Zn, Sr, Ca, and P ions in implant fixture for biomedical applications using a variety of techniques. We prepared a fixture of the implant as a sample for the experiment. Potentiostat (PARSTAT 2273, Princeton Applied Research, USA) was used to perform precipitation in an electrolyte solution containing a bioactive substance added to the surface of the fixture. The electrochemical setup for precipitation in the electrolyte solution containing the bioactive material was composed of three electrode structures, which were a platinum electrode and a saturated carbon electrode (SCE) as a counter electrode and a reference electrode, respectively. The electrolytic solution for HA deposition is performed by cyclic voltammetry over a potential range of -1.5 V to 0 V using 0.03 M Ca(NO_{3})_{2}·4H_{2}O + 0.015 M NH_{4}H_{2}PO_{4} at 80 ° ± 1 at a scanning speed of 100 mV/s. three different numbers of cycles were employed: 10, 30, and 50.

To determine biocompatibility and bioactivity after precipitation in each cycle, the samples were immersed in simulated body fluid (SBF) for 12 hours. SBF was prepared by dissolving ion concentrations (mM) of Na^{+} 142.0, K^{+} 5.0, Ca^{2+} 2.5, Mg^{2+} 1.5, Cl^{-} 147.8, HCO_{3}^{-} 4.2, HPO_{4}^{2-} 1.0 and SO_{4}^{2-} 0.5. This concentration is almost the same as human plasma. Tris-hydroxymethyl-aminomethane [(CH_{2}OH)_{3}CNH_{3}] and hydrochloric acid were used to adjust the pH and temperature of SBF to 7.4 and 36.5 °C, respectively.

The morphology and structure of the surface were investigated by field emission scanning microscopy (FE-SEM, S-4800, Hitachi, Japan), energy dispersive x-ray spectroscopy (EDS, Inca program, Oxford, UK), and thin film X-ray diffractometer (TF-XRD, X’pert, Philips, Netherlands). (Supported by NRF: 2015H1C1A1035241 & NRF: 17GJ1006; hcchoe@chosun.ac.kr)
Morphology of PEO-treated Surface on Ti-6Al-4V after nanotube Formation

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Plasma electrolyte oxidation (PEO) treatment that combines the high voltage spark and electrochemical oxidation is a novel method to form ceramic coatings on light metals such as titanium and its alloys. This method is an excellent reproducibility, and easily shape and size control of morphology on the Ti alloy. The aim of this study was to investigate the functional element coating on Ti-6Al-4V alloy by PEO treatment after nanotube formation by anodic titanium oxide (ATO) technique on implants. The specimens were used commercially available Ti-6Al-4V alloy and polished with sandpaper from 100 to 2000. And then it was anodized at room temperature in a 1M H$_3$PO$_4$ electrolyte solution containing 0.8 wt.% NaF to form the nanotube oxide surface structure on the Ti-6Al-4V alloy using potentiostat. This experiment was done in two ways; firstly, the initial nanotube layer was removed after the nanotube formation, and then the PEO treatment was performed in a solution containing Mg and Zn ions. For another test group, the first step was the removal of nanotubes after nanotube formation, the second step was the elimination of nanotubes again after nanotube formation, and finally, PEO-treatment was performed in the solution containing Mg and Zn ions for doping the functional element on the implant surface.

After the performing anodization, the surface morphology and nanotube formation process on Ti-6Al-4V alloy were investigated by X-ray diffraction, field-emission scanning electron microscopy, and energy dispersive X-ray spectroscopy. (Supported by NRF: 2015H1C1A1035241 & NRF: 17GJ1006; hcchoe@chosun.ac.kr)
Morphology of Bone Formation on PEO-treated on Ti-6Al-4V on Solution Containing Function Element

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Excellent mechanical properties, such as biocompatibility, corrosion resistance and hardness and wear resistance of titanium and its alloys are widely used in dental and orthopedic implants sector. They can be connected directly to the bones. However, they do not form chemical bonds with bone tissue. Plasma electrolytic oxidation (PEO), which combines high-voltage spark and electrochemical oxidation, is a new method of forming a ceramic coating on light metals such as titanium and its alloys. This is reproducible and economical, and it is relatively easy to control the size and shape of the nanostructure.

The physiologically active substances contained in the PEO treatment were Ca, P, Si, Mn, Mg, Zn, and Sr ions. These ions play an essential role in the normal bone growth and metabolism of the human skeletal tissues. In addition, deficiency can cause a variety of problems such as osteoporosis.

In this study, morphology of bone formation on PEO-treated on Ti-6Al-4V on solution containing function element. The PEO treatment was carried out at an applied voltage of 280 for 3 minutes. Bone-like apatite formation was performed in SBF solution for 1, 3, 5, and 7 days. The morphology of PEO-treated Ti-6Al-4V alloy containing physiologically active substances was investigated using FE-SEM, EDS and XRD. (Supported by NRF: 2015H1C1A1035241 & NRF: 17GJ1006; hcchoe@chosun.ac.kr)
Bone-like Apatite Formation on PEO-treated Ti-6Al-4V in Solution Containing Mn, Mg, and Si Ions after Plasma Electrolytic Oxidation

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Excellent mechanical properties, such as biocompatibility, corrosion resistance and hardness and wear resistance of titanium and its alloys are widely used in dental and orthopedic implants sector. They can be connected directly to the bones. However, they do not form chemical bonds with bone tissue. Plasma electrolytic oxidation (PEO), which combines high-voltage spark and electrochemical oxidation, is a new method of forming a ceramic coating on light metals such as titanium and its alloys. Because the size and shape control of nanostructures is relatively easy, this is reproducible and economical.

Silicon (Si), manganese (Mn), and magnesium (Mg) are useful for bones. In particular, Si has been shown to be essential for normal bone, cartilage growth and development. Because manganese is low in the body, calcium, phosphate and phosphatase exits the cell and affects bone remodeling. The lack of Mn in the human body can cause osteoporosis. Preliminary studies have shown that Mg, which plays an essential role in the normal growth and metabolism of skeletal tissues in vertebrates, can be detected as trace elements in teeth and bones.

The purpose of this study was to study the bone-like apatite formation on PEO-treated Ti-6Al-4V in solution containing Mn, Mg, and Si ions after plasma electrolytic oxidation. The anodized alloy was prepared with a 270V to 300V voltage. Bone-like apatite formation was performed in SBF solution for 1, 3, 5, and 7 days. The shape of the PEO-treated Ti-6Al-4V alloy containing Mn, Mg and Si ions was examined by FE-SEM, EDS and XRD. (Supported by NRF: 2015H1C1A1035241 & NRF: 17GJ1006; hcchoe@chosun.ac.kr)
**Electrochemical Characteristics of PEO Surface Formed in Solution Containing Mn, Mg and Si ions**

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Excellent mechanical properties, such as biocompatibility, corrosion resistance and hardness and wear resistance of titanium and its alloys are widely used in dental and orthopedic implants sector. However, they do not form chemical bonds with bone tissue. Plasma electrolytic oxidation (PEO), which combines high-voltage spark and electrochemical oxidation, is a new method of forming a ceramic coating on light metals such as titanium and its alloys. Because the size and shape control of nanostructures is relatively easy, this is reproducible and economical. Silicon (Si), manganese (Mn), and magnesium (Mg) are useful for bones. In particular, Si has been shown to be essential for normal bone, cartilage growth and development. Because manganese has a low content in the body, calcium, phosphate and phosphatase exits the cell and influences bone remodeling. Preliminary studies have shown that Mg, which plays an essential role in the normal growth and metabolism of skeletal tissues in vertebrates, can be detected as trace elements in teeth and bones.

In this study, electrochemical characteristics of PEO surface formed in solution containing Mn, Mg, and Si ions were investigated using various experimental devices. Using PEO in Ti implants, a series of Si-Mn-Mg coatings are produced with 5% and 10% substitutions, respectively. Have performed the buoyancy kinetic polarization and AC impedance test the corrosion reaction in the solution at a rate similar to 0.975NaCl using Potentiostat, scan rate 1.67mV / s and the electric potential range was -1500mV ~ + 2000mV. In addition, the AC impedance was performed at frequencies between 10MHz and 100kHz for corrosion resistance. (Supported by NRF: 2015H1C1A1035241 & NRF: 17GJ1006; hcchoe@chosun.ac.kr)
Study on Improvement of Interface Properties in Al$_2$O$_3$/Si Structure Using SiO$_2$ Buffer Layers

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Nitric acid (HNO$_3$) oxidation of Si (NAOS) has been used to fabricate the ~1.4 nm SiO$_2$ buffer layers between Al$_2$O$_3$ layers grown by atomic layer deposition (ALD) and Si substrate to improve the interface and electric properties. Investigations of the electrical characteristics of TiN/Al$_2$O$_3$/SiO$_2$/p-Si structure revealed that the leakage current density at a gate voltage of -1 V decreases by about two orders magnitude from 8.1×10$^{-9}$ A/cm$^2$ of TiN/Al$_2$O$_3$/p-Si. This leakage current density was further decreased about three orders of magnitude than one of the without buffer layers after post-metallization annealing (PMA) at 250 °C for 10 min in a 5 vol.% hydrogen atmosphere. These results are attributed to an increase of equivalent oxide thickness (EOT), as well as a decrease in equilibrium defect density ($N_d$) and fixed oxide defect density ($N_f$). The interface state density ($D_{it}$) at 0.11 eV on the valence band is decreased about one order of magnitude after addition of SiO$_2$ layers, and it is further decreased one order of magnitude after PMA treatment. The high defect density resulted from a misorientation structure of interface of Al$_2$O$_3$/Si was reduced by fabricating the SiO$_2$ buffer and performing the PMA treatment which can remove the dangling bonds.

In this study, we could achieve the very low leakage current density and confirm not only the difference of Al$_2$O$_3$/Si and Al$_2$O$_3$/SiO$_2$/Si structures by spectrum of X-ray Photoelectron Spectroscopy (XPS) but also the decrease in electrical defect density by current-voltage (I-V) curves.

**KEYWORDS:** nitric acid oxidation of silicon, leakage current density, high-k dielectric
Morphology after Nanotube Formation on Ti-6Al-4V Alloys by Several Steps

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Ti and Ti-6Al-4V alloys are widely used in dental and orthopedic implants due to their excellent biocompatibility, high corrosion resistance and excellent mechanical properties. However, Ti-6Al-4V alloys were difficult to meet all clinical requirements and, for that reason, surface modifications were performed to improve functions such as biological, chemical and mechanical properties of the material. Therefore, an experiment was conducted to form nanotubes on the surface of porous TiO$_2$ using anodic oxidation reaction. Nanotube modification technology improves integration of bone tissue. In addition, nanostructures formed on the surface of titanium alloys increase bone adhesion, especially in implants, and nanotubes have been used to improve bone tissue integration. Nanotube nucleation and growth are also critical for cell proliferation and attachment. Cyclic (several-step) anodizations were used for surface modification of these titanium alloys. The method for anodic titanium oxide (ATO) is to first form the nanotubes, secondly to remove the nanotube layer, and finally to reconstitute the nanotubes. Alloy is used as anode and platinum electrode is used as cathode electrode. Voltage of 30 is applied for 2 hours in 1M H$_3$PO$_4$ and 0.8wt% NaF electrolyte. The surface of the nanotubes formed by this method is analyzed by FE-SEM, EDS, and XRD.

In this study, it is focusing on the phenomenon of nanotube nucleation and growth for the Ti-6Al-4V alloy using the ATO method. (Supported by NRF: 2015H1C1A1035241 & NRF: 17GJ1006 ; hcchoe@chosun.ac.kr)
Corrosion Characteristics of Ca, P, Sr, and Si Ions from PEO-treated Ti-6Al-4V Alloy Surface

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Ti-alloys are widely used as metallic biomaterials in dentistry and orthopedics due to their excellent biocompatibility and mechanical properties. However, due to the low biological activity, it is difficult to grow bone directly on the surface of titanium implants. For this reason, surface treatment of plasma electrolytic oxidation (PEO) was used for dental implants. Strontium (Sr) and silicon (Si) ions may be added to the PEO-treated surface in an electrolyte containing these ions to enhance bioactivity at the surface. The presence of Sr in the coating promotes osteoblast activity and differentiation, thus inhibiting osteoclast genesis and proliferation. And Si has been found to be essential for normal bone, cartilage growth and development. In this study, electrochemically released characteristics of Ca, P, Sr, and Si ions from PEO-treated Ti-6Al-4V alloy surface was re-searched using various experimental instruments. DC power is used and Ti-6Al-4V alloy was subjected to a voltage of 280 V for 3 minutes in the electrolyte containing 5, 10, 20M% Sr ion and 5M% Si ion. The morphologies of PEO-treated Ti-6Al-4V alloy by electrochemical anodization were examined by field-emission scanning electron microscopes (FE-SEM), energy dispersive x-ray spectroscopy (EDS), x-ray diffraction (XRD) and corrosion analysis using AC impedance and potentiodynamic polarization test in 0.9% NaCl solution at similar body temperature using a potentiostat with a scan rate of 1.67mV/s and potential range from -1500mV to + 2000mV (Supported by NRF: 2015H1C1A1035241 & NRF: 17GJ1006; *hcchoe@chosun.ac.kr)
Electrodeposition of Ga from GaCl$_3$ in DMSO bath and influence of NH$_4$NO$_3$

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The application of gallium that has received the most attention is the production of semiconducting materials. Especially, Gallium oxide (Ga$_2$O$_3$) and Gallium nitride (GaN) are considered as one of the most suitable materials. These materials are used in the production of several electronic parts such as solar cell, LEDs and optical detectors, etc. However, the fabrication methods of these Ga-based semiconducting materials generally require very expensive equipment. Therefore, a synthesis of Ga-based semiconducting materials using an electrodeposition method from alkaline solutions or ionic liquids has been reported by some researchers. But, process from organic solvents has not been reported. Organic solvents can offer a better thermal stability and larger potential window than aqueous solutions.

In this study, the electrodeposition of gallium from the dimethyl sulfoxide (DMSO) including gallium chloride (GaCl$_3$) was investigated to get a better knowledge for making of various Ga-based compounds. Also, we examine into the influence of ammonium nitrate (NH$_4$NO$_3$) on the deposition of Ga. The Pt and Cu plates were used as a working electrode and Pt coil was used as a counter electrode. Analytical methods including cyclic voltammetry (CV), SEM, EDX and XRD were used to confirm properties of reaction on the surface of electrodes.

It was found that the electrodeposition of Ga could be made on a Cu electrode from GaCl$_3$ in the presence of NH$_4$NO$_3$ from the DMSO at room temperature. And it was shown that NH$_4$NO$_3$ helps to form a Ga layer because a larger amount of gallium was contained in the electrodeposited layer from the DMSO solution containing NH$_4$NO$_3$. Especially, it was confirmed that the Ga can be electrodeposited without hydrogen evolution reaction (HER) interference on the electrodes when compared with the results in aqueous solution.
Electrochemical behavior of Li, Mg or Al in polar organic solvents of Dimethylsulfone groups

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Al, Mg and Li are all base metals and cannot be electrodeposited in aqueous solution. However, it is now known that Al can be electrodeposited from AlCl$_3$ by using dimethylsulfone (DMSO$_2$) which is a polar organic solvent for Al, attracting attention as a plating technique. In this study, cyclic voltammetry (CV) was performed on AlCl$_3$–DMSO$_2$ bath and electrochemical behavior of AlCl$_3$–DMSO$_2$ bath was investigated. Electrochemical behavior was also investigated for Mg and Li by measuring CV for MgCl$_2$–DMSO$_2$ bath and LiCl–DMSO$_2$ bath. For each bath, constant potential electrolysis was carried out with the aim of metal deposition at the cathode. For Al, CV and constant potential electrolysis were performed on a bath using dimethyl sulfoxide (DMSO) or dimethyl sulfide (DMS) as a solvent, which is a reduction system of DMSO$_2$. Selection of the reference electrode is often a problem in non-aqueous solvents such as ionic liquids and organic solvents. A pseudo reference electrode in which a metal wire is immersed in a bath is often used, but for this time, a reference electrode was also made. It was thought that the prepared reference electrode was sufficiently resistant to 403K and was useful as a reference electrode of non-aqueous solvent types such as organic solvent and ionic liquid. Both the cathode current and the anode current flow well in the AlCl$_3$–DMSO$_2$ bath. In the case of the LiCl–DMSO$_2$ bath and the MgCl$_2$–DMSO$_2$ bath, the flowing current was small as compared with the AlCl$_3$–DMSO$_2$ bath, and precipitation at the cathode as the metal and the metal oxide could not be detected even when the constant potential electrolysis was performed. In the AlCl$_3$–DMSO$_2$ bath, DMSO$_2$ was stable, and it was found that that changes to DMSO or DMS (bath decomposition) hardly occurred.
Effect of NaOH concentration on PEO film formation of AZ31 magnesium alloy in an aqueous electrolyte containing carbonate and silicate ions

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In this work, PEO (Plasma Electrolytic Oxidation) film formation behavior of AZ31 Mg alloy was studied as a function of NaOH concentration in 1 M Na\textsubscript{2}CO\textsubscript{3} + 0.5 M Na\textsubscript{2}SiO\textsubscript{3} under the application of a constant current by voltage-time curves and by observation of surface appearances and morphologies of the PEO films. The PEO film formation voltage decreased with increasing concentration of NaOH in the solution containing carbonate and silicate ions. The PEO film formation voltage showed very low values less than 70V when the concentration of NaOH is more than 1 M in the solution containing carbonate and silicate ions. Observation of surface appearances and morphologies of the PEO films showed that uniformity of the PEO films can be improved as the NaOH concentration increases.

Effect of Electrolyte Composition on The Formation Behavior of Plasma Electrolytic Oxidation Films on Al1050 Alloy

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In this study, effect of electrolyte composition on the formation behavior of Plasma Electrolytic Oxidation (PEO) coatings on Al1050 alloy was investigated by analyses of micro-arc generation behavior, voltage-time curves, and morphologies of the PEO coatings. Electrolyte was composed of 0.01 M ~ 1.0 M NaOH and 0 ~ 2.0 M Na\textsubscript{2}SiO\textsubscript{3}. Micro-arching of Al1050 alloy was generated in 0.01 M NaOH solution, anodic voltage was increased more than 500 V and micro arcs was appeared on the whole surface of specimen. During PEO process, size of micro arcs becomes larger and spatial density of micro arcs was decreased with time. Thickness and roughness of PEO film increased with time and thickness of PEO film on Al1050 alloy reached to 10 μm after 20 minute of PEO treatment. In x M Na\textsubscript{2}SiO\textsubscript{3} + 0.01 M NaOH solution, micro-arcs appeared also on the whole surface and size of the arcs increased with time. With increasing Na\textsubscript{2}SiO\textsubscript{3} concentration, size of micro arcs rapidly increased. Thickness and roughness of PEO film increased with increasing PEO treatment time more rapidly than that without silicate ions, and time to local burning decreased with increasing Na\textsubscript{2}SiO\textsubscript{3} concentration. Group arcing was generated by linear discharge in 1 M Na\textsubscript{2}SiO\textsubscript{3} solution containing more than 0.2 M NaOH.
Electrochemical Characteristics of Functional Hydroxyapatite Coatings on the Ti-6Al-4V Alloys

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Titanium and its alloys have been used in orthopedic and dental implants due to their biocompatibility, good corrosion resistance, and elastic modulus such as bone and high mechanical strength. However, it is known that titanium is biologically inert and has a long duration of healing. For this reason, research has been conducted to improve implant bonding to bone tissue. Recently, many researchers have focused on the addition of bioactive elements such as calcium, phosphorus, magnesium, silicon, zinc, manganese, and strontium. Biologically active substances are essential trace metals found in normal bones and in all tissues and are required for normal amino acid, lipid, protein and carbohydrate metabolism. It reduces bone anomalies such as bone thickness and length reduction and deformation, increases bone density, and promotes bone metabolism and growth.

In this study, corrosion behaviors of functional hydroxyapatite coatings on the Ti-6Al-4V alloys were investigated after electrochemical precipitation methods. The precipitation solution was prepared by adding 5% each of Si, Zn, Mn, Mg, and Sr ions as biologically active substances. The solution temperature was maintained at 80 ° C for 10, 30 and 50 cycles. The surface of the alloy after precipitation was observed by scanning electron microscope (FE-SEM) and ion detection of surface precipitates was performed by energy dispersive X-ray spectrometry (EDS) analysis. And phase analysis of the coated alloy was carried out through XRD. Ion release test was carried out using potentiodynamic and AC impedance method in 0.9% NaCl solution. Potentiodynamic was performed at a potential range of -1500 mV to +2000 mV with a scan rate of 1.67 mV / s. The AC impedance was set in the frequency range of 10 mHz to 100kHz and the AC amplitude was set to 10mV at 5 points / decade.

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Cyclic Surface Modification on Ti-6Al-4V Alloy Using Plasma Electrolytic Oxidation after Nanotube Formation Electrochemical Methods

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Plasma electrolytic oxidation (PEO) is considered to be a promising technology because it can create a surface layer with good adhesion to a Ti substrate and has a low cost advantage. In addition, nanotubes show excellent biocompatibility, and the open volume in the tubes may be exploited as a drug release platform and so on. Generally, dental implant is needed the hybrid surface for cell nucleation and proliferation. Therefore, in this study, it was focused on the formation of hybrid surface on the dental implant surface for osseointegration.

The specimens used in this study were prepared by polishing the Ti-6Al-4V alloy with 100-2000 grit of the commercialized Ti-6Al-4V alloy, washing it with ethyl alcohol for 5 minutes and drying it. For the formation of hybrid surface, two experiments were carried out; firstly, nanotube was formed in a 1M H₃PO₄ containing 0.8 wt% NaF at room temperature on Ti-6Al-4V alloy by potentiostat. Secondly, after the nanotube formation, the initial nanotube layer was removed and then the surface of the alloy was coated with hydroxyapatite (HA) using PEO.

After the experiments, phase transformation, and morphology of surface modification on Ti-6Al-4V alloys were analyzed by X-ray diffraction, field emission scanning electron microscopy, and energy dispersive X-ray spectroscopy.

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Electrochemical Charateristics of Bioactive Element Coatings on PEO-treated Ti-6Al-4V Alloy

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Titanium and its alloys have been used in orthopedic and dental implants due to their biocompatibility, good corrosion resistance, and elastic modulus such as bone and high mechanical strength. However, it is known that titanium is biologically inert and has a long duration of healing. For this reason, research has been conducted to improve implant bonding to bone tissue.

Plasma electrolytic oxidation (PEO) has recently attracted attention. PEO is considered to be a promising technology because it can create a surface layer with good adhesion to a Ti substrate and has a low cost advantage.

Recently, many researchers have focused on the addition of bioactive elements such as Calcium, Phosphorus, Magnesium, Silicon, Zinc, Manganese and Strontium. Biologically active substances are essential trace metals found in normal bones and in all tissues and are required for normal amino acid, lipid, protein and carbohydrate metabolism. It reduces bone anomalies such as bone thickness and length reduction and deformation, increases bone density, and promotes bone metabolism and growth.

In this study, bioactive element release form the PEO-treated Ti-6Al-4V surface was researched using various experimental instruments. The surface of the alloy after PEO treatment was observed by scanning electron microscope (FE-SEM), and ion detection in surface and pore was performed in energy dispersive X-ray spectrometry (EDS). Phase analysis of the coated alloy was carried out through XRD. Ion release test was carried out using potentiodynamic and AC impedance method in 0.9% NaCl solution. Potentiodynamic was performed at a potential range of -1500mV to +2000mV with a scan rate of 1.67mV / s. The AC impedance was set in the frequency range of 10MHz to 100kHz and the AC amplitude was set to 10mV at 5 points / decade.

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Corrosion Behaviors of Zn, Si, Mn-doped Hydroxyapatite Films Formed on the Ti-6Al-4V Alloy by Plasma Electrolytic Oxidation

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Titanium and its alloys have been used in the fields of orthopedics and dentistry due to their abilities to exhibit high specific strength, high corrosion resistance, and chemical inertness particularly in biological circumstances. Despite these attractive properties, their passive films were somewhat bioinert in nature so that sufficient adhesion of bone cells to implant surface was delayed after surgical treatment. Recently, the Plasma electrolyte oxidation (PEO) of titanium metal has attracted a great deal of attention. Silicon (Si) in particular has been found to be essential for normal bone and cartilage growth and development. Zinc (Zn) plays very important roles in bone formation and immune system regulation, and is also the most abundant trace element in bone. Manganese (Mn) is important in terms of protein synthesis, the manganese is insufficient, the generation of cartilage synthesis of the organic matrix is low is delayed, thickness and length decreased abnormal bone generation is performed. Si, Zn, and Mn has a beneficial effect on bone.

The objective of this work was research on ion release of Zn, Si, Mn-doped hydroxyapatite films formed on the Ti-6Al-4V alloy by plasma electrolytic oxidation. Anodized alloys was prepared at 270V–300V voltage in the solution containing Zn, Si, and Mn ions. Ion release test was carried out using potentiodynamic and AC impedance method in 0.9% NaCl solution. The surface characteristics of PEO treated Ti-6Al-4V alloy were investigated using XRD, FE-SEM, AFM and EDS.

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Si-Zn-Mn-hydroxyapatite Coating on Ti-6Al-4V Alloy by Plasma Electrolytic Oxidation

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Titanium and its alloys have been used in the field of dental and orthopedic implants because of their excellent mechanical properties and biocompatibility. Despite these attractive properties, their passive films were somewhat bioinert in nature so that sufficient adhesion of bone cells to implant surface was delayed after surgical treatment.

Recently, plasma electrolyte oxidation (PEO) of titanium metal has attracted a great deal of attention as a comparatively convenient and effective technique and good adhesion to substrates and it enhances wear and corrosion resistances and produces thick, hard, and strong oxide coatings.

Silicon (Si) in particular has been found to be essential for normal bone and cartilage growth and development. And, zinc (Zn) has been shown to be responsible for variations in body weight, bone length and bone biomechanical properties. Also, manganese (Mn) influences regulation of bone remodeling because its low content in body is connected with the rise of the concentration of calcium, phosphates and phosphatase out of cells. Si, Zn, and Mn have a beneficial effect on bone.

The objective of this work was research on bone-like apatite formation on Si-Zn-Mn-hydroxyapatite coating on Ti-6Al-4V alloy by plasma electrolytic oxidation.

Anodized alloys were prepared at 280V voltage in the solution containing Si, Zn, and Mn ions. The simulated body fluid (SBF) solution was prepared for biocompatibility and observation of the formation bone-like apatite on the PEO-treated alloy.

The surface characteristics of SBF treated Ti-6Al-4V alloy were investigated using OM, XRD, FE-SEM, AFM, and EDS.

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Cell Culture on the Hydroxyapatite Coatings by Plasma Electrolytic Oxidation

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Pure Ti and Ti alloys are promising for dental and orthopedic implants because of their excellent corrosion resistance, excellent mechanical properties and biocompatibility. However, Ti alloys have been difficult to satisfy all clinical requirements. Surface modification has been performed to improve the functionality such as biological, chemical and mechanical properties of the material, and functional surface coatings such as plasma electrolytic oxidation (PEO) have been introduced. PEO is a new method of forming ceramic coatings on light metals such as titanium alloys. This electro chemical process uses a high voltage to generate spark discharge, and this occurs when the PEO voltage is higher than the dielectric breakdown voltage of the oxide film. PEO has proven to be a simple, controllable, and cost effective process. And the functional elements were added to the PEO coating to add the ions to the electrolyte to enhance bioactivity. Especially, calcium (Ca), phosphorus (P), strontium (Sr), manganese (Mn), Magnesium (Mg) and zinc (Zn), which are constituents of the body’s bones, are added to the electrolyte of the ion, because they contain various crystalline minerals.

In this study, it was expected that the bonding of the metal surface and the bone would be improved by doping the biodegradable hydroxyapatite (HA) coating film on the Ti alloy, and it would have a positive effect on the bioactivity, and the surface morphology analysis and the cell growth and differentiation experiment were performed after PEO treatment; 280V, 3min, and various electrolytes. (Supported by NRF: 2015H1C1A1035241 & NRF: 17GJ1006 ; hcchoe@chosun.ac.kr)
Corrosion Behavior of RF-sputtered Zn and Si Coatings on PEO-treated Ti-6Al-4V

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Ti alloys (typically Ti-6Al-4V) display excellent corrosion resistance and biocompatibility. However, Ti and its alloys are not bioactive. Therefore, they do not chemically bond to the bone, whereas they physically bond with bone tissue. Electrochemical deposition method is an attractive technique for the deposition of hydroxyapatite (HAp). However, the adhesions of these coatings to the Ti surface needs to be improved for clinical used.

Plasma electrolyte oxidation (PEO) enables control in the chemical composition, porous structure, and thickness of the TiO₂ layer on Ti surface. In addition, previous studies have concluded that the presence of Ca⁺² and PO₄³⁻ ion coating on porous TiO₂ surface induced adhesion strength between HAp and Ti surface during electrochemical deposition.

Radio frequency(RF) magnetron sputtering in the various PVD methods has high deposition rates, high-purity films, and excellent uniform layers for depositing a wide range of materials like a hydroxyapatite.

Silicon (Si) in particular has been found to be essential for normal bone and cartilage growth and development. Zinc (Zn) plays very important roles in bone formation and is also the most abundant trace element in bone. Therefore, the objective of this work was to study electrochemical characteristics of RF-sputtered Zn and Si coatings on HA coated Ti-6Al-4V by PEO treatment.

The coating process involves two steps: 1) formation of porous TiO₂ on Ti-6Al-4V at high potential. A pulsed DC power supply was employed. 2) Electrochemical tests were carried out using potentiodynamic and AC impedance methods. The morphology, the chemical composition, and the micro-structure analysis of the sample were examined using FE-SEM, EDS, and XRD. The enhancements of the HAp forming ability arise from Si/Zn-TiO₂ surface, which has formed the reduction of the Si/Zn elements. The promising results successfully demonstrate the immense potential of Si/Zn-TiO₂ coatings in dental and biomaterials applications. (Supported by NRF: 2015H1C1A1035241 & NRF: No. 17GJ1006 ; hcchoe@chosun.ac.kr).
Bone Formation Behaviors of Sr-Si-HA Surface on Ti-6Al-4V after Plasma Electrolytic Oxidation Treatments

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Metallic biomaterials have been mainly used for the fabrication of medical devices for the replacement of hard tissue such as artificial hip joints, bone plates, and dental implants. Because they are very reliable on the viewpoint of mechanical performance. This trend is expected to continue. Especially, Ti and Ti alloys are bioinert. So, they do not chemically bond to the bone, whereas they physically bond with bone tissue. For their poor surface biocompatibility, the surface of Ti alloys has to be modified to improve the surface osteoinductivity. Recently, ceramic-like coatings on titanium, produced by plasma electrolytic oxidation (PEO), have been developed with calcium- and phosphorus-enriched surfaces. Also included the influences of coatings, which can accelerate healing and cell integration, as well as improve tribological properties. However, the adhesions of these coatings to the Ti surface need to be improved for clinical use. Particularly Silicon (Si) has been found to be essential for normal bone, cartilage growth and development. This hydroxyapatite, modified with the inclusion of small concentrations of silicon has been demonstrating to improve the osteoblast proliferation and the bone extracellular matrix production. Strontium-containing hydroxyapatite (Sr-HA) was designed as a filling material to improve the biocompatibility of bone cement. In vitro, the presence of strontium in the coating enhances osteoblast activity and differentiation, whereas it inhibits osteoclast production and proliferation. The objective of this work was to study shapes of bone-like apatite formation on Sr and Si-doped hydroxypatite surface of Ti-6Al-4V alloy after plasma electrolytic oxidation. Anodized alloys was prepared at 270V–300V voltages with various concentrations of Si and Sr ions. Bone-like apatite formation was carried out in SBF solution. The morphology of PEO, phase and composition of oxide surface of Ti-6Al-4V alloys were examined by FE-SEM, EDS, and XRD (Supported by NRF: 2015H1C1A1035241 & NRF: 17GJ1006 ; hcchoe@chosun.ac.kr).
HA Precipitates Coating Functional Elements on the Ti-6Al-4V Alloy by Electrochemical Methods

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In this study, electrochemical deposition was applied to electrolytes containing Ca, P, Mg, Mn, Sr, Zn, and Si ions. The surface of the Ti-6Al-4V alloy and the shape of the precipitate formed on the Ti-6Al-4V alloy surface were investigated. Ti-6Al-4V ELI discs and fixtures for implants were used as a sample. Ti-6Al-4V alloys are promising in the field of dental and orthopedic implants due to their excellent biocompatibility, high corrosion resistance and excellent mechanical properties, but they cannot meet all clinical requirements, so that biological, chemical and mechanical surface modification. Hydroxyapatite (HA) precipitation coating showed excellent adhesion between metal and bone, and biocompatibility was further improved by using Mg, Mn, Sr, Zn and Si ions as bioactive materials. The HA precipitation was synthesized from 0.03M Ca(NO$_3$)$_2$·4H$_2$O + 0.018M NH$_4$H$_2$PO$_4$ at 80 °C and the Ca / P ratio of the electrolyte was 1.67. HA precipitates doped with Mg, Mn, Sr, Zn, and Si ions were synthesized from 0.024M (NO$_3$)$_2$·4H$_2$O + 0.0165M NH$_4$H$_2$PO$_4$ + 0.0015M Mg(NO$_3$)$_2$·6H$_2$O, 0.0015M MnCl$_2$·4H$_2$O, 0.0015M Sr(NO$_3$)$_2$, 0.0015M Zn(NO$_3$)$_2$·6H$_2$O, 0.0015M Na$_2$SiO$_3$·9H$_2$O. A single voltammetry cycle was composed of a 2 s deposition time (td) with potential E ranging from $-1.5$ V to 0 V (vs. SCE electrode) and scan rate of 100mV/s, followed by a break time (tb) of 2 s. The number of cycles used for electroless HA deposition was 10, 30, and 50, respectively. Surface properties were investigated using SEM, EDS, and XRD. (Supported by NRF: 2015H1C1A1035241 & NRF: 17GJ1006 ; hcchoe@chosun.ac.kr)
HA Coatings Containing Functional Material on the PEO-treated Ti-6Al-4V Alloy

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Titanium and its alloys that have a good biocompatibility, corrosion resistance, and mechanical properties such as hardness and wear resistance are widely used in dental and orthopedic implant applications. Especially, plasma electrolytic oxidation (PEO) is a good surface treatment for osseointegration between bone and dental implant. Also, hydroxyapatite (HA) can serve a good biocompatibility on the implant surface including Mg, Mn, Sr, Zn and Si elements.

In this study, Ti-6Al-4V ELI disks were used as specimens for PEO and HA coating. The electrochemical coating was carried out on the Ti-6Al-4V alloy in electrolyte containing calcium (Ca), phosphorus (P), magnesium (Mg), manganese (Mn), strontium (Sr), zinc (Zn), and silicon (Si) ions after PEO treatment in the solution containing Ca and P ions. And then, HA coatings with Mg, Mn, Sr, Zn, and Si ions were performed in the solution of (NO$_3$)$_2$·4H$_2$O + NH$_4$H$_2$PO$_4$ + Mg(NO$_3$)$_2$·6H$_2$O, MnCl$_2$·4H$_2$O, M Sr(NO$_3$)$_2$, Zn(NO$_3$)$_2$·6H$_2$O, and Na$_2$SiO$_3$·9H$_2$O using voltammetry with cycle of 5, 10, and 20 from −1.5 V to 0 V (vs. SCE electrode). The morphology changes of the coatings on the PEO treated Ti-6Al-4V alloy surface were observed using FE-SEM, FT-IR, XRD, and scratch tester. (Supported by NRF: 2015H1C1A1035241 & NRF: 17GJ1006 ; hcchoe@chosun.ac.kr)
Characteristic of Electrochemically Doped Non-Noble Metal TiO$_2$ Nano-Tube for Chlorine Evolution Reaction (CER)

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Dimensional stable anode (DSA) is well known for chlorine evolution reaction (CER) electrode with excellent activity and stability. Most commercial DSAs consisted of multi coating layers with noble metal oxide, such as RuO$_2$, IrO$_2$ and/or PdO$_2$, on the Ti substrate. The DSA is also active and durable electrode. However, it’s very expensive due to the noble metal oxide. Thus the non-novel and cost-effective DSA electrode for chlorine evolution should be developed. In this research, electrochemically prepared non-noble metal TiO$_2$-Nano-Tube (TNT) used for CER electrode. The TNT arrays are prepared by electrochemical anodization of Ti plate in 1M H$_3$PO$_4$ and 0.3M HF at various applied voltages and reaction times. After annealing process, the TNT was doped by H$^+$ in cathodization at 1M KHCO$_3$. CER activity was tested in 1 psu bay salt at constant current (26mA/cm$^2$) and residual chlorine concentration was evaluated by N,N-diethyl-p-phenylenediamine sulfate (DPD) method. As a result of the research, the measured residual chlorine concentration using TNT electrode was ca. 65% compared with the commercial DSA.
Effects of Electrical Parameters on the Surface Characteristics of Pulse Plasma Electrolytic Oxidation on Aluminum Alloy

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Plasma electrolytic oxidation (PEO) is a promising surface modification technique in which ceramic oxide film is produced on valve metals such as Al, Ti and Mg in electrolyte solution. The resulting coating possesses excellent resistance to corrosion and erosion. In the PEO coating process, there are many process parameters which have great effects on the qualities of the PEO coating, among which the electrical parameters play an important role on the surface characteristics of the coating. In this study, Al alloy was treated by plasma electrolytic oxidation in an alkaline solution using unipolar pulse DC power source with varying duty ratio. Influences of electrical parameters on the PEO coating layer were investigated by using various microstructural and electrochemical characterization techniques. The result indicated that the electrical parameters such as duty ratio is proved to produce significant effects on the surface morphology of the PEO coating layer.

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Hydrophobic and electromagnetic interference surface using multi-wall carbon nanotube and inorganic binder

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It is a problem that electronic equipment malfunctions on account of contamination as well as electromagnetic waves in the autonomous car and electric vehicles. In order to solve this problem, coating solutions having electromagnetic interference(EMI) function and hydrophobic property were developed. The coating solutions were prepared by ultrasonicating isopropyl alcohol(IPA), MWCNT and inorganic binder. After spray coating on the aluminum specimen and cured, contact angle was measured as 150°, thermal conductivity as 234W/mK, and a surface resistance as 10^3 Ω / sq. thus hydrophobic and EMI surface was confirmed.
Biomechanical Stability of TiN and DLC coated Rod for Pedicle Screw System


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A Rod in spinal pedicle screw system is important part to retain the stability for orthopedic surgery with spinal disc disorder, in according from recent clinical reports, approximately 32.4% of failure are reported to be caused failure with rod breakage and loosening between pedicle screw and rod system. To reduce these problems, pedicle screw system have to be considered for improving the surface properties on the rod by hardening modification. Diamond like carbon (DLC) and titanium nitride (TiN) coating techniques are well known to achieve higher hardness than bare substrate and good adhesion with their base material, which are expected to improve frictional durability as a part of spinal pedicle screw system. Therefore, the object of this study was to evaluate whether the mechanical properties of rod could be improved by applying DLC and TiN coating, which need to have high abrasion resistance.

As materials and methods, TiN coating, and DLC coating rod specimens were prepared by cathodic vacuum arc deposition technology and ion beam deposition, respectively. The surface characteristics of coating layer were investigated by field-emission scanning electron microscopy (FE-SEM), energy dispersive X-ray spectroscopy (EDS), X-ray diffraction (XRD), and the mechanical properties were evaluated by axial gripping capacity and axial torsional gripping capacity test based on ASTM F1798 standard.

As results from EDS and XRD, the composition and crystal structure of TiN and DLC coated surface were verified. The hardness value was increased by TiN and DLC coating, and the DLC coating surface has the highest value. The gripping capacity also showed higher value for TiN and DLC coated specimen than that of non-coated (Ti alloy) surface. The surface morphology of gripping tested specimen showed rougher scratched surface from Ti alloy than TiN and DLC coated layer. The results of this study could be suggested that the TiN and DLC coating in rod can improve axial gripping capacity and axial torsional gripping capacity. Also, the application of TiN and DLC coating techniques in pediatric pedicle screw system considered improving the mechanical properties, and these surface coating suggests the possibility of clinical application for vertebral correction of children and adolescents is sufficient.

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High-temperature Oxidation of Aluminum Hot-Dipped 2.25%Cr-1%Mo Steel

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This paper presents the microstructure, chemical and phase composition of aluminum hot-dipped 2.25Cr-1Mo (ASTM P22) steel, which were analyzed before and after high-temperature oxidation in air. The Al hot-dipped steel consisted of an Al-rich topcoat containing a small amount of Al\textsubscript{13}Fe\textsubscript{4} precipitates and an underlying alloy layer containing Al\textsubscript{13}Fe\textsubscript{4} and Al\textsubscript{5}Fe\textsubscript{2} precipitates. The alloy layer transformed to three different sub-layers after oxidation. The Al hot-dipped steel was oxidized at 700-1000 °C for up to 20 h. An AlFe reaction layer formed closed to the steel substrate at 700 °C. It transformed to elongated columnar grains at 900-1000 °C. With an increase in temperature, the outer part of the alloy layer transformed to Al\textsubscript{5}Fe\textsubscript{2} between 700 to 800 °C, AlFe at 900 °C, and AlFe\textsubscript{3} at 1000 °C. After oxidation, an α-Al\textsubscript{2}O\textsubscript{3} oxide scale formed on the surface. Chromium tended to segregated near the scale surface. The forming tendency of the thin α-Al\textsubscript{2}O\textsubscript{3} scale increased with an increase in temperature, being accompanied with the formation of a small amount of Fe\textsubscript{2}O\textsubscript{3} at 1000 °C. The XRD/EPMA results revealed that oxidation resistance of 2.25Cr-1Mo (ASTM P22) steel increased much by aluminum hot-dipping.

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High-temperature Corrosion of CrAlSiN thin film in N\textsubscript{2}/0.1%H\textsubscript{2}S-mixedGas

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A CrAlSiN thin film was deposited on tool steel substrate using Cr and AlSi cathodes by a cathodic arc plasma deposition system, and corroded in N\textsubscript{2}/0.1%H\textsubscript{2}S-mixed gas at 1000 °C for 20-100 h in order to find the effect of CrAlSiN thin film on the high-temperature corrosion of the tool steel in the H\textsubscript{2}S environment. H\textsubscript{2}S is a quite corrosive gas that can significantly increase the corrosion rate of steels, because hydriding and sulfidation can occur simultaneously. It usually forms fast growing, friable, non-protective mixed scales of sulfides and/or hydrides. Hence, it is important to protect the steel substrate against high-temperature corrosion using a suitable coating. This study aims to investigate the high-temperature corrosion behavior of the CrAlSiN thin film in the N\textsubscript{2}/0.1%H\textsubscript{2}S-mixed gas. The CrAlSiN thin film displayed good corrosion resistance, because the formed oxide scales consisting of Cr\textsubscript{2}O\textsubscript{3}, \alpha-Al\textsubscript{2}O\textsubscript{3}, and amorphous SiO\textsubscript{2} effectively suppressed the formation of sulfides and hydrides on the surface.

Acknowledgments

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The non-aqueous electrolysis for rapid synthesis of silver nanoparticles by pulse waveform was investigated in an ionic liquid of 1-butyl-3-methylimidazolium chloride ([C₄mim]Cl) with silver chloride (AgCl). From linear sweep voltammetry results, a limiting current density corresponding maximum reduction rate of silver was observed at -1.4 V vs. Pt-QRE. Potentiostatic reduction of silver in the non-aqueous electrolyte was conducted at -1.4 V vs. Pt-QRE. Silver nanoparticles could be rapidly synthesized using highly pulsed potential without any side reaction such as hydrogen evolution in the non-aqueous electrolyte. The electrodeposited silver nanoparticles were uniformly distributed on the electrode surface without any impurities. The size distribution of silver nanoparticles was able to be controlled by pulse electrolysis variables such as pulse duration and overpotential. To investigate antimicrobial activity of silver nanoparticles, film attached method was used. As a result, we could demonstrate that the electrode electrodeposited silver nanoparticles showed perfect antimicrobial effects.
Protection of lacquer surface from UV irradiation using TiO$_2$/SiO$_2$ composite photocatalyst

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TiO$_2$ is photocatalyst material, which shows super-hydrophilic and oxidative decomposition properties by UV irradiation. Water spreads out by forming a thin layer on TiO$_2$ and carries away dust particles from surface. In addition, organic compounds are decomposed by strong oxidation power$^1$. Lacquer is natural paint based on urushiol gathered from a lacquer tree. Due to its superior durability (acid, base, and water-resistance) and high adhesion, the lacquer has been applied to various substrates including tableware for a long time. However, the lacquer deteriorates and decreases in luster by UV irradiation$^2$. In this work, the coating of TiO$_2$/SiO$_2$ composite film on lacquer was conducted in order to absorb UV light, aiming to prevent deterioration and give the self-cleaning properties. Self-cleaning effects was evaluated by water contact angle, and lacquer deterioration was evaluated by IR spectrum and color difference measurement under UV irradiation as well as an observation of its surface morphology by laser microscope.

TiO$_2$/SiO$_2$ composite film was coated by dip coating or spray coating with SiO$_2$ slurry and TiO$_2$/SiO$_2$ slurry sequentially on lacquer substrates which were pretreated by ozone. Samples were dried 100 °C for 1 h after coating. The decrement of water contact angle was confirmed after 1 h UV. This was due to the photo-induced hydrophilicity of TiO$_2$ by UV irradiation. Fig.1 shows the change of IR spectrum with UV irradiation time, a peak around 1700 cm$^{-1}$ increased and a peak around 1050 cm$^{-1}$ changed by keeping UV irradiation. This was because C=O bond increased, and also changed into ester bond of primary alcohol. Laser microscope observation revealed that the lacquer surface became rougher after UV irradiation due to the degradation. As the surface became rough, the diffused reflectance light increased, causing the decrease of the luster of the lacquer surface. When the TiO$_2$/SiO$_2$ layer was coated, no change in IR spectrum or color difference measurement was observed at the time of UV irradiation. It was suggested that the protection of UV light by photo catalyst is possible. Therefore, coating of TiO$_2$/SiO$_2$ composite film is needed to more absorb UV irradiation and to protect the lacquer surface from UV light by photocatalytic effects.

References:
1) Sanjay S. Latthe, et al., Coatings 2014. 4. 497-507.
2) Ogawa T, Urushi-no-Kagaku (Science of Lacquer) (in Japanese)
Development of Flow Type Polysaccharide Sensor Using TiO\textsubscript{2} Ink

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Screen printing has been widely applied for the fabrication of electrochemical devices. The paper-based electrochemical devices are easy to use, require small volumes of reagents and sample, provide rapid analysis, and are readily disposable. In addition, since the main component of the paper is cellulose fiber, it is possible to infiltrate the liquid into the hydrophilic fiber without requiring an active pump or an external supply source\textsuperscript{1}. TiO\textsubscript{2}, which is a photocatalyst shows extremely strong oxidizing power by irradiation with ultraviolet light. If TiO\textsubscript{2} ink can be prepared and screen printed on a paper substrate, the reaction system which has proceeded with a complicated reaction can proceed with a simple system and can be quantitatively determined at low cost. In this study, a reaction part on which a TiO\textsubscript{2} ink was printed was placed upstream, and a three electrode chip was placed downstream. We have developed a device that detects the substance at photoreacted upstream on the electrode part.

The design of the cell in this study is shown in Fig.1. TiO\textsubscript{2} ink was prepared by adding 20 wt% of titanium dioxide nanoparticles (P-25, Nippon Aerosil Co.,Ltd.) using EC vehicle (200FTR, Nissin Kasei Co., Ltd.) or polyvinylidene fluoride (PVdF) as a binder and stirring for 30 minutes. In order to evaluate the printability of the printed TiO\textsubscript{2} ink, rheometer (MCRxx2, Anton Paar) was used. Carbon ink was printed on the working electrode and counter electrode, and Ag/AgCl ink was printed for the reference electrode.

TiO\textsubscript{2} ink using EC vehicle and PVdF as a binder was prepared. As a result of screen printing using these inks, it was confirmed that the ink using EC vehicle was printable. From the results of rheometer, it is considered that viscosity is higher and decreased by increasing shear rate when EC vehicle is used. The prepared TiO\textsubscript{2} ink was printed using a screen printing machine, and a decomposition experiment of methylene blue was carried out by a flow type. From the results of the experiments, by irradiating the TiO\textsubscript{2} layer with ultraviolet light, the methylene blue solution became transparent showing the decomposition. Therefore, it was confirmed that prepared TiO\textsubscript{2} ink produced has oxidizing power and photocatalytic activity by irradiation with ultraviolet light even when it was used in flow system. Next, chronoamperometry was measured in 5 mM K\textsubscript{3}[Fe(CN)\textsubscript{6}] solution using three electrodes chip. As a result, it was confirmed that K\textsubscript{3}[Fe(CN)\textsubscript{6}] changed to K\textsubscript{4}[Fe(CN)\textsubscript{6}] by UV irradiation. By using this TiO\textsubscript{2} ink and three electrodes chip, it becomes possible to create a flow type sensor.

Characterizations of Cr-P-PTFE Composite Coatings Electroplated from a Trivalent Chromium-Based Bath.

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Chromium carbide coatings have some superior properties such as high hardness, toughness, chemical stability, strength and corrosion resistance. Due to these properties, they are widely applied on tools and dies as protective coating, and they have high potentiality to substitute the common coatings, such as the hard chrome coating used to protect a mold. Chromium-carbon deposits can be formed from Cr(III) electroplating solution containing organic complexants, such as oxalate, formate, urea, carbamide and glycine. Apparently, the carbon element existing in those organic complexants in the solution is co-deposited in the coating following the reduction of metal chromium. By comparing with Cr(VI) deposit, chromium-carbon deposits display superior mechanical characteristics, and reveal better corrosion resistance than Cr(VI) plating. The hardness is even higher than hard chromium after heat treatment. Moreover, the \( \text{Cr}_3\text{C}_2 \) has a conductivity as large as \( 68\times10^6 \Omega^{-1}\text{cm}^{-1} \), allowing employ as a conductive material. Polytetrafluoroethylene (PTFE) is widely used in the chemical, mechanical and electronic industries because of its corrosion and wear resistance and its inherently uniform coating thickness. In this study, the incorporation of PTFE particles into the Cr-P matrix can take advantage of the different properties of Cr-P alloy and PTFE. The influences of complexing agent in Cr(III) electroplating procedure and properties of Cr-P-PTFE deposits were studied. Our results showed that the affect plating rate, plating efficiency, composition, and properties of Cr electroplating.
Effect of ultrasonic on morphology and hardness of Ni-P-Al\textsubscript{2}O\textsubscript{3} electroless composite coatings.

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When an electroless plating process is performed in an ultrasonic field, a number of well-known effects occur as a result of acoustic cavitation, including enhanced mass transport, thinning of the diffusion layer and localized heating. This study focused on the microstructure, Alumina content, grain size, roughness, micro-hardness and corrosion resistance of the Ni–P-Al\textsubscript{2}O\textsubscript{3} composite coatings, which were influenced by the ultrasound parameters. It has been established that the deposited layers with Al\textsubscript{2}O\textsubscript{3} micro-dispersive grains are characterized by process repeatability, so it is to control parameters such as time, pH and temperature. The surfaces are characterized by evenly distributed volume dispersion of aluminum oxide particles and by identical thickness of the whole coating. The positions of high-angular peaks of the Ni phase indicate the displacements related to the presence of a Ni-P solid solution and to the macroscopic internal stresses. The micro hardness of the Ni-P-Al\textsubscript{2}O\textsubscript{3} coating is relatively high. The results of the EDXS analysis verify the required distribution of elements in the produced layer. It has been that the adherence of the Ni-P-Al\textsubscript{2}O\textsubscript{3} to the Ni-P coating was better than that of the Ni-P coating to the matrix.
Enriching the Capacity of Nanoporous Anodic TiO$_2$-TiO-TiN Composite Films on Ti as Anode Materials for High-Safety Lithium-ion Battery

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Recently, nanoporous or nano-tubular TiO$_2$ films on Ti foils formed by anodization have attracted great attention as promising candidate anode materials for Li-ion batteries (LIBs) to substitute the commercially used graphite. Usually, anodic TiO$_2$ films were formed by anodizing Ti foils in ethylene glycol containing corrosive F- ions and a small amount of water, which may cause environmental concerns. It is highly desirable to explore an aqueous electrolyte with less corrosion and low cost, considering on the practical applications.

The present study proposed a facile anodizing process to fabricate nanoporous TiO$_2$-TiO-TiN composite films on Ti foils by using a nitric-based aqueous electrolyte system without containing corrosive F- ions. The microstructures, chemical composition, and crystalline structure of the anodized specimens before and after annealed were investigated using FE-SEM, EDS, TEM (FIB), XRD, and XPS. Moreover, the charge-discharge performances of nanoporous TiO$_2$-TiO-TiN composite films on Ti foils were investigated as binder-free electrode materials for LIBs were also investigated.

As shown in Fig.1a, the anodic titania film formed in nitric-based electrolyte possessed a nanoporous structure with cylindrical pores of ~50 nm and nano-laminated layers with layer thickness of ~30 nm, indicating a 3D nanostructure. Figure 1b shows that the as-anodized titania film contained polycrystalline cubic TiO in addition to amorphous TiO$_2$ and transferred to anatase TiO$_2$ and highly crystalline TiO. Figure 1c gives the XPS spectra of N1s for the as-anodized specimen. The spectra after Ar$^+$ sputtering revealed a strong peak close to the binding energy of TiN, thus confirming the formation of TiO$_2$-TiO-TiN composite film. Moreover, the nanoporous TiO$_2$-TiO-TiN composite films exhibited the highest initial discharge capacity of 440 μAh cm$^{-2}$ upon ~1 μm film and a high Coulombic efficiency around 100%, indicating the promising candidate materials as high-energy density anode material for LIBs.

**Fig.1** (a) Cross-sectional TEM image, (b) XRD patterns, and (c) XPS spectrum of porous anodic titania films formed in nitric-based aqueous electrolytes.
Electroless Sn Deposition on Copper from Choline Chloride-based Deep Eutectic Solvent

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Recent, development and Miniaturization in the technology of automobile electric parts have heightened the need for the reliability of electronic parts is becoming a problem. In order to secure the reliability of electroless tin plating in electronic parts and automobile electric parts, a method of increasing the plating thickness is used. However, existing plating methods have limitations. In the present study, the electroless tin-plated electrolyte was prepared using Deep eutectic solvent(DES) and its properties were confirmed. Choline chloride-based DES was used and the effect of additives such as malonic acid, oxalic acid and ethylene glycol on viscosity and crystallization temperature were investigated. Water and dimethylthiourea were added to promote the electroless plating reaction. Electrolytic tin plating was performed at 70°C using DES electrolyte. The plating thickness of tin plated layer was 1.5μm when malonic acid and dimethylthiourea were used. The addition of a small amount of water increased the plating speed and thickness, and a maximum 2μm tin plating layer was obtained for 30min plating.
Effect of Etching Temperature on Adhesion and Surface Morphology of Acrylonitrile-Butadiene-Styrene (ABS) Based Material for Plating

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Acrylonitrile–butadiene–styrene (ABS) is currently widely used in plating of automobile parts such as door handles, emblems, buttons on interior panels, and various plastic products. An ABS coating can be obtained by etching, electroless plating, or electroplating, which can provide a decorative surface that exhibits excellent performance in plating adhesion, abrasion resistance, and corrosion resistance. Since the ABS surface and the metal-plating layer do not diffuse into each other, there is no chemical bond between the two materials. Therefore, the plating adhesion can be improved by irregularities (anchor holes) on the ABS surface, which can be obtained through etching. In our study, a mixed solution of chromic acid and sulfuric acid was used as the etchant, and the adhesion between the ABS coating and the metal-plating layer was evaluated with variations in the etching temperature (50, 60, 70 degrees) and etching duration (3, 6, 9, 12, 15 minutes). The ABS surface and the surface of the plated layer were examined to determine their morphology after etching, and their surface areas were measured with a laser microscope. As the etching temperature was increased, both the plating adhesion and surface areas increased. The ratio between the surface areas of the ABS and plating layers was analyzed as a function of the etching temperature, and its correlation with the adhesion strength was investigated.
The effects of organic additives on the via filling performance in high-aspect-ratio through silicon via

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The technique of filling a high aspect ratio through silicon via (TSV) without voids is a key technology for efficient three-dimensional stacking of semiconductors. Typically, the filling process of TSV is accomplished by the electrolytic plating, which facilitates void-free filling by adding three kinds of organic additives. Three kinds of additives are well known as suppressors, accelerators and levelers depending on their role.

In this study, we investigated the via filling performance by adjusting the types of additives. In case of electroplating in the absence of additives, optical microscopy results revealed that the voids were formed in the bottom of via since the opening was rapidly clogged. With addition of suppressor and accelerator, the seam void was formed in the center of via due to the conformal growth. When the leveler was additionally added, no defect was observed.
Effect of Nano-Al₂O₃ Additive on Manganese Phosphate Composite Conversion Coating of Carbon Steel

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Manganese phosphate is an industrial coating material used to reduce friction and improve lubrication in sliding components. In this study, the morphology and tribological properties of uncoated carbon steel and carbon steel coated with only manganese phosphate and with manganese phosphate with nano-Al₂O₃ were investigated. This work shows the effects of nano-Al₂O₃ on the formation of manganese phosphate coatings on steel. The microstructure and morphology of the coatings were studied by scanning electron microscopy(SEM), X-ray diffraction(XRD), energy-dispersive X-ray spectroscopy(EDS) and X-ray Photoelectron Spectroscopy(XPS). The electrochemical corrosion behavior of the prepared coatings was investigated in a 3.5 wt. % NaCl solution by a potentiostat-galvanostat device. The main component of the layer is hureaulite (Mn,Fe)₅(H₂(PO₄))₆·4H₂O. It was also realized that the micro-hardness, wear resistance, corrosion performance, and passivation behaviors of the coatings are improved by adding nano-Al₂O₃ particles.

Keywords: Manganese phosphate coating, nano-Al₂O₃, carbon steel, morphology, composite chemical treatment
Ultrathin Silver Telluride Nanowire Films for Flexible Resistive Switching Device

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Elemental chalcogen and chalcogenide are well-known semiconductors with narrow band gap energy, which exhibit interesting properties, such as photoconductivity, nonlinear optical response, thermoelectric, and piezoelectric responses. Ultrathin tellurium nanowire (10 nm, thickness) can be synthesized with large quantity in aqueous medium. We demonstrated that these tellurium nanowire were fabricated into mono-layered and well-aligned film through air-water interface trap. Chemical transformation was used to convert tellurium nanowire film to silver telluride film without structure collapse despite the large volume change. The well-aligned mono- and multi-layered silver telluride film shows bipolar, reversible, and novolatile switching on rigid and flexible substrates.

KEYWORDS
Tellurium, Silver telluride, Chemical transformation, Resistive switching, Nanowire

The effects of internal stress of nickel electrodeposits on the hydrogen evolution reaction

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Hydrogen is recognized as one of the most promising clean energy candidates to replace fossil fuels due to its high energy density and infinite availability. The hydrogen evolution reaction (HER), which is a half reaction of water decomposition, plays an important role in the production of pure hydrogen fuel, but requires the use of a low-cost and highly active electrode catalyst to promote reaction kinetics. Nickel is well known as a low cost HER catalyst and has been reported to have excellent activity as an alkaline electrolyzer. However, despite the continuing efforts to improve the nickel-based catalysts, studies on improving the properties of pure nickel have been rarely published.

In this study, the correlation between the internal stress and the HER activity of the nickel electrode prepared by the electrodeposition method was experimentally verified. Electrodeposition was performed by varying the concentrations of coumarin (COU) or 1,3,6-naphthalenetrisulfonic acid trisodium salt (NTS). When COU and NTS were added, tensile and compressive stresses were induced, respectively. This is attributed to the incorporation of hydrogen or sulfur from the additive into the nickel matrix. On the other hand, excellent HER activity was observed in the compressive stress induced nickel electrode, indicating that the bonding between the nickel atom and the adsorbate was weakened due to the downshift of the antibonding state.
Facile Synthesis of Solvent Casted Arabic Gum Coated Carbonyl Iron Microspheres and Their Magnetorheological Characteristics

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Magnetorheological (MR) fluids are a class of smart materials whose rheological behaviors such as yield stress, shear viscosity, and storage modulus can be reversibly tuned from a fluid-like to a solid-like state depending on magnetic field. Thereby, MR fluids attract huge attentions in various industrial applications including damper, torque transducer or polishing devices. While soft magnetic carbonyl iron (CI) microparticles are widely used due to their superior magnetic properties as well as their appropriate size, the large density of CI particles has limited their further engineering applications. To reduce the density gap between the magnetic particle and medium oil, an effective way to cover CI with gum material is considered because it has strong hydrogen bonding so that gum could attract each other. The hydrogen bonds of the gum may play a very important role, because they can build a network throughout all the particles coated with the gum, resulting in a smaller density than pure CI particle, as a direct way of reducing density of the magnetic MR particles to improve the sedimentation.

In this study, we fabricated Arabic gum (AG) coated CI particles via a solvent casting method to reduce the density gap between CI particles and silicone oil. These synthesized CI/AG microparticles, of which the rough surface is compactly wrapped by AG, are obtained, as confirmed by scanning electron microscopy. Thermal stability and magnetic properties of both particles also confirmed by thermogravimetric analysis and vibration sample magnetometer, respectively. Both steady shear and dynamic behavior from the rheological measurements were obtained to be increased with applied magnetic field strengths. By investigating steady shear test, both MR fluids with and without coating showed typical Bingham fluid characteristics under an external magnetic field, implying the formation of solid-like chain structures in the fluids. Arabic gum coated CI based MR fluids has a lower shear stress than MR fluid with pure CI particles due to non-magnetic Arabic gum particle coating. The dispersion stability of the CI/AG suspension was higher than that of the pure CI suspension. These results were attributed to the rough surface and low density of the CI/AG particles.
Effect of electrolytic factors on the color tone of anodized aluminum film

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Aluminum has worse physical and chemical properties such as corrosion resistance and abrasion resistance than other metallic materials. Thus, anodic oxidation is widely used industrially in order to improve these properties. Aluminum anodic oxidation not only improves the strength, abrasion resistance, and corrosion resistance, but also leads to adsorption of dyes into the pores, with sizes ranging from 30 nm to 100 nm, regularly arranged on the aluminum surface to form anodic oxide films having various colors. The pore size, spacing, and depth vary greatly depending on the anodic oxidation conditions such as anodic oxidation voltage, type and concentration of the electrolyte, and temperature. It is also known that the color tone of the anodized film changes depending on the concentration of the dye and the coloring time. In this study, the effect of electrolytic conditions on the color tone of the anodic oxide film was investigated, and the color tone of the oxide film was quantitatively analyzed using a spectrophotometric colorimeter. In order to quantitatively analyze the dye adsorbed on the pore of the oxide film, UV-visible spectrophotometer was used. It was confirmed that the color tone of the anodized film increased with increasing anodic oxidation time and coloring time. Moreover, the amount of dye adsorbed on the oxide film increased as the concentration of the dye became higher and the color tone became increasingly sharper. We also investigated the relationship between the amount of dye and the electrolysis conditions. When the anodic oxidation time was prolonged, the thickness of the oxide film increased, thereby increasing the surface area where the dye can be adsorbed. With increase in coloring time, more dye was adsorbed into the same oxide film. Thus, the higher the dye concentration, the greater is the amount of dye adsorbed under the same area within the same time.
Electrochemical Nanopattern Formation on Ti Surface: Comparison with TiO$_2$ nanotube surfaces in vitro bioactivity

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Schmuki et al. shows promising results with TiO$_2$ nanotube topologies for a biocompatible implant surface. Remarkable is that a maximum in cell activity for vitality, proliferation, motility and differentiation was obtained with nanotube diameters of approx. 15 nm. However, the nanotube surface by far has not been practically used in clinics due to the fact that the nanotube layer itself is brittle. In this study, we introduce a new approach to prepare a robust metallic surface by Electrochemical Nanopattern Formation (ENF) process. The ENF surface, smooth (as control) and the TiO$_2$ nanotube surfaces were compared in the cellular response. In the results, AFM and SEM analysis shows the ENF has the highest roughness. Cells cultured on TiO$_2$ nanotube 15nm and ENF exhibit polygonal morphology and spread more filopodias at 1 and 3 days. The number of cells on all the specimens increased with time, especially ENF group shows significantly higher a proliferation of preosteoblastic cells. Significant increases in ALP activity on day 7 and 14 and calcium deposition on day 14 nd 21 were observed for TiO$_2$ nanotube 15nm and ENF Ti surface. From the data, we can conclude that the ENF surface might be a highly favorable path to improve the bioactivity of Ti-based implants.

References:
1) Park, J., Bauer, S., Von Der Mark, K. and Schmuki, P., Nano Letters, 7 (6), pp. 1686-1691.
Anodic Formation of Self-Organized Aluminium Alloy Oxide Nanoporous Layers

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Ever since Masuda et al. reported hexagonally ordered porous alumina structures, enormous studies of the formation of highly ordered self-organized nanoporous aluminium oxide layer are performed. The self-organized nanoporous aluminium oxide layer can be grown on aluminium metal by anodization in acidic solution such as sulfuric acid, oxalic acid or organic acid. The well-defined aluminium oxide layers offer a wide potential for use in industrial field such as membrane for filtration, template for one-dimensional structures, surface treatment of merchandise exterior for anti-corrosion and decoration. However, the anodization approach is limited to relatively pure aluminium metal substrate.

Recently, the demands of surface treatment of aluminum alloys are incredibly increased due to its high availability in automobile, aviation.

In the present work, we introduce the state of art anodization approach to form aluminium oxide layer on aluminum alloy. The new anodization method were carried out in phosphate based hot glycerol electrolyte. The pore diameters of nanoporous aluminium oxide layers can be controlled in a range of 30 ~ 50 nm by anodization temperature and applied voltage.
Fabrication of Free-Standing Open-Ended Large Diameter TiO\textsubscript{2} Nanotube Membranes

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Self-organized TiO\textsubscript{2} nanotubes have been considered one of the attractive nanostructures due to their high surface area, fast electron transport rate. For these reasons many efforts are given to use them in various applications such as solar-cells, photocatalysts and bio-medical devices. In particular, TiO\textsubscript{2} membranes have been considered the most promising application for filtration of pollutant, bio macromolecules. However, the inner diameters of TiO\textsubscript{2} nanotubes membranes are limited in the range of few tens of nanometers. Because, diameters of TiO\textsubscript{2} nanotubes can be controlled by applied potential but the potentials are limited under break down voltage (around 80V).

In our research, we reveal that the break down voltages can be controlled by electrolyte composition. And the higher applied voltage leads to enlarge the diameter of TiO\textsubscript{2} nanotubes.

The present presentation shows the key-parameters of anodization condition for fabricating the large diameter TiO\textsubscript{2} nanotubes. Moreover, under optimum condition, the large diameter TiO\textsubscript{2} nanotubes can be lifted off from Ti metal substrate with open-end bottom layers. We will also present the critical factor to fabricate open-ended large diameter TiO\textsubscript{2} nanotubes.

Thermodynamic Calculation of Surface Tension of Liquid High Carbon Steels

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The surface properties of metal melts and liquids have both scientific and technological importance especially for dealing with classical soldering, brazing, sintering and recent additive manufacturing process. To understand the solidification process and control the shape of liquid droplet, there have been a number of methods to determine the surface properties of liquids such as surface tension. However, those methods are limited by their chemical reactivity and high melting points. In the present work, a recently suggested thermodynamic approach based on basic thermodynamics was adopted to for calculation of the surface tension of steel. Surface tension was calculated for various high carbon tool steel grades and thermodynamic properties, which are necessary for this thermodynamic approach of surface tension, were calculated using Thermo-calc software with TCFE9 steel database.
Synthesis and Characterization of Nicr Nanofiber for Hydrogen Evolution Reaction

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Hydrogen evolution reaction(HER) was studied over NiCr nanofibers(NFs) prepared by electrospinning method and oxidation/reduction heat treatment for alkaline water electrolysis. The physicochemical and electrochemical properties such as average diameter, lattice parameter, HER activity of synthesized NiCr NFs could be modified by proper electrospinning process condition and reduction temperature. It was shown that Ni\textsubscript{3.68}Cr\textsubscript{0.32} NFs had average diameter from 151 to 273 nm. Also, it exhibited the overpotential between 0.419 V and 0.526 V at 1 mA/cm\textsuperscript{2} and Tafel slope of -334.75 mV to -444.55 mV per decade in 1 M KOH solution. These results indicate that NiCr NFs with reduction heat treatment at 600 °C show thinnest diameter and highest HER activity among the other catalysts.
Influence of Coating Amount on Chlorine Evolution using RuO$_2$-PdO-TiO$_2$ Electrodes

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Dimensionally stable anode (DSA) is usually used as chlorine evolution reaction (CER) electrode with high electrocatalytic activity and durability with simple preparation methods. Generally, the Ti and the transition metal oxide (RuO$_2$, IrO$_2$, TiO$_2$, SnO$_2$, PbO$_2$, MnO$_2$ and Ta$_2$O$_5$) are used as the electrode and the catalyst layer at the DSA, respectively. Most catalyst layer consisted also the expensive noble metal oxides. Therefore, the amount of noble catalyst loading should be reduced.

In this study, the RuO$_2$-PdO-TiO$_2$ electrode was prepared by the bush method with metal loading of 0.5, 0.8, 1.0, 1.4, 2.0, 2.4 and 3mg/cm$^2$, followed by the thermolysis at atmosphere. The structure, morphology, and electrocatalytic activity of the prepared electrode were characterized by several physicochemical and electrochemical analyses. Obviously, “mud-cracks” appeared in all the prepared electrodes from SEM images as a result of sintering test. The efficiency was increased with amount of catalyst loading. But the CER efficiency has not increased above 91% from 1.4mg/cm$^2$. 
Fabrication of Gelatin/PVA scaffold with aligned topological cues for Cardiac Tissue Regeneration

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Tissue engineering has been developed to fabricate a micro environment mimicking a natural structure of tissues/organs. In this concept, various factors should be considered to design a scaffold such as biomaterial, surface topography, and three-dimensional (3D) architecture. For cardiac tissue regeneration, it is important to provide cells an elastic platform for contraction and anisotropic cues for cellular alignment and elongation. To achieve this goal, we chose gelatin for high biocompatibility and behavior of large deformation allowing for the cellular contraction. However, gelatin itself may not provide aligned topological cues, and less organized cellular morphology limits for realistic clinical applications. To overcome this problem, we mixed gelatin and PVA for better alignment. Then, the mixture of gelatin and PVA was built in 3D structure using low-temperature 3D printing process. For control scaffolds, we used pure gelatin to fabricate a scaffold without aligned cues. We compared cellular activities of myocardium (H9C2) cultured on aligned/non-aligned topological cues. As a result, the scaffold with aligned cues revealed better cellular alignment and elongation. We propose the potential of 3D scaffold with aligned guidance for cardiac tissue engineering.
In bone tissue regeneration, bioceramic scaffolds have been widely used for its biocompatibility and osteoconductivity. However, it has been a challenge to overcome brittleness and hardness of growth factor release control. To extent this problem, natural or synthetic polymers have been combined to improve functionality of bioceramic scaffolds to overcome the shortcomings. In this study, we used the composite of bioceramic, natural polymer and platelet rich plasma (PRP) to fabricate scaffolds with controlled drug delivery function, and fabricated a 3D structure using low temperature 3D printing process. The fabricated biocomposite 3D scaffold showed proper mechanical modulus compared with that of conventional natural polymer/ceramic scaffolds, and growth factor release was observed until 35 days. Also, to evaluate scaffolds in cytotoxicity and cellular activities, preosteoblasts (MC3T3-E1) cell line was used. All scaffolds with different composite conditions showed non-cytotoxicity, and the scaffolds with PRP showed enhanced cell growth and differentiation compared to those of control scaffolds without PRP. Based on these results, we expect that the bioceramic/natural polymer biocomposite scaffold can be used for bone tissue regeneration.
Fabrication of biomimetic 3D model with gelatin and bioceramic using multi nozzle 3D printing system for bone tissue regeneration

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In bone tissue regeneration, development of biological substitutes to recover massive bone defect which cannot self-healing has been main goal. Bone is mainly composed with mineral and organic materials, and has two different structure (compact and spongy structure). The compact structure of natural bone shows high mechanical properties and low porosity, while spongy structure has high porosity and relatively low modulus. In this study, α-tricalcium phosphate (α-TCP) and gelatin has been chosen as the mineral and organic material to mimic the real bone formation, and multi nozzle 3D printing system used for fabrication of concentric cylinder 3D model. To achieve physical properties of the compact and spongy structure of natural bone, various weight fraction of gelatin (5, 10, 15, 20 and 25 wt%) was contained in the mineral/organic composite solution, while the volume fraction of α-TCP was fixed at 80 v/v%. Hence, inner and outer cylinder of the scaffolds mimic the spongy and compact structure of natural bone, respectively, and three types of 3D models with different diameter of inner cylinder part. The biomimetic 3D models were evaluated in terms of various physical activities, including porosity and mechanical properties. Also, preosteoblasts (MC3T3-E1) are cultured on the biomimetic 3D models to evaluate biocompatibility, cell proliferation, and differentiation. Based on the physical characteristics and cellular activities of the biomimetic models, we optimize ratio of inner and outer diameter of the bone mimic scaffolds for bone tissue regeneration.
Fabrication of α-TCP/Cellulose 3D Fibrous Scaffold and Cellular Activities for Bone Tissue Regeneration

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In tissue engineering, cellulose has been commonly used as a biomaterial fabricated into micro/nano fibers. The micro/nano-fibers are similar to the structure of extracellular matrix (ECM), and provide cells a ECM-like environmental condition promoting cell-adhesion and proliferation. However, to build up layers for 3D structure with cellulose micro/nano-fibers is difficult owing to low process-ability and low mechanical property. Moreover, cellulose itself has low osteoconductivity for bone tissue regeneration. To compensate for these limitations, we designed a new composite structure, cellulose with α-tricalcium phosphate (α-Ca\textsubscript{3}(PO\textsubscript{4})\textsubscript{2}; α-TCP) which enhances mechanical property and cellular activities including osteoconductivity. To obtain a 3D bioceramic scaffold, electrohydrodynamic printing (EHDP) process was used for fabricating the structure consisted of micro/nanofibrous struts. This EHDP process was examined with various conditions such as the mixture ratio of α-TCP/cellulose, flow rate, distance between nozzle and target ground, and applied electric field. Then, using the fabricated cellulose/α-TCP composite scaffold, we cultured preosteoblasts (MC3T3-E1) to examine cellular activities and compare them with the control scaffold consisted of pure cellulose. As a result, the fibrous composite scaffold revealed higher cellular activities in cell-adhesion, -growth, and -differentiation. These results suggest that α-TCP/cellulose fibrous structure can be a promising tissue engineering scaffold for biomimetic structure similar to natural ECM and reasonable osteoconductivity.
Biomaterials such as gelatin have been widely used in fabrication of a regenerative medicine, a scaffold, for various tissue regeneration. In hard tissue regeneration, the scaffold should provide cells biocompatible factors and mechanical supports for successful cell proliferation and differentiation in a 3D environment. Gelatin has been used as a main component of the regenerative scaffold for its high biocompatibility and biodegradability. However, the low mechanical properties of gelatin have been an obstacle for its use as regenerative 3D scaffold. In this study, we propose a mechanically enhanced gelatin scaffold fabricated with poly (vinyl alcohol) (PVA). The scaffolds were built in 3D mesh structure by a low temperature 3D printing process, and were crosslinked with polyphenolic reagent. Then, mechanical properties of the scaffolds with various ratios of gelatin and PVA were evaluated. To observe biocompatible properties, osteoblast-like cells (MG63) were cultured on the scaffolds. As a result, the mechanical strength of the gelatin scaffold was enhanced as the ratio of PVA in the scaffold increased, while cellular activities of the scaffold were decreased. Therefore, the optimal ratio of gelatin and PVA in the scaffold has been determined. Based on these results, we expect that the gelatin/PVA scaffold can be a useful regenerative material for various hard tissue regeneration.
Evaluation of corrosion resistance for anodized Al Alloy
with applying electric charge

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Aluminum alloys have poor corrosion resistance compared to the pure aluminum due to the additive elements. Thus, anodizing technology artificially generating thick oxide films are widely applied nowadays in order to improve corrosion resistance. Anodizing is one of the surface modification techniques, which is commercially applicable to a large surface at a low price. However, most studies up to now have focused on its commercialization with hardly any research on the assessment and improvement of the physical characteristics of the anodized films. Therefore, this study aims to select the optimum temperature of sulfuric electrolyte to perform excellent corrosion resistance in the harsh marine environment through electrochemical experiment in the seawater upon generating porous films by variating the temperatures of sulfuric electrolyte.

To fabricate uniform porous film of 5083 aluminum alloy, we conducted electro-polishing under the 25 V at 5 °C condition for three minutes using mixed solution of ethanol (95 %) and perchloric (70 %) acid with volume ratio of 4:1. Afterward, the first step surface modification was performed using sulfuric acid as an electrolyte where the electrolyte concentration was maintained at 10 vol.% by using a jacketed beaker. For the second step surface modification process (identical to the step 1), etching was performed using mixture of chromic acid (1.8 wt.%) and phosphoric acid (6 wt.%) at 60 °C temperature for 30 minutes. As a result, the case of surface modification presented a significantly lower corrosion current density than that without modification, indicating excellent corrosion resistance.

Acknowledgement
This research was a part of the project titled ‘Construction of eco-friendly Al ship with painting, and maintenance /repairment free’, funded by the Ministry of Oceans and Fisheries, Korea.”
Surface Modification of Di-Electric Material using Photo Pretreatment for FOWLP

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Recently smartphone technology constant requires the performance advancement of the semiconductor chip for reinforced multi-tasking functions and optimized power consumption for longer battery life. Due to the miniaturized semiconductor processes, die size continues to decrease whereas the number of I/O pin increases, therefore increased the semiconductor packaging size, leading to packaging needs that agree with the recent trends of mobile and wearable devices that require thinner and smaller sizes.

The minimization of the semiconductor packages is now being emphasized, where WLP (Wafer Level Package) technology is emerging as an alternative to the FC-CSP (Flip Chip-Chip Scale Package) and WB/FC-BGA (Wire Bonding/Flip Chip-Ball Grid Array) technology using traditional PCB (Printed Circuit Board), due to their technological limitations and increased cost.

WLP technology can innovatively decrease the thickness and volume of the semiconductor packages. As an advanced packaging technology compared to FI-WLP (Fan In-Wafer Level Package), FO-WLP (Fan Out-Wafer Level Package) can accommodate the standardized ball layout, and incorporate even thinner chips. Smaller thickness can increase thermal conductivity and reduced electric path can increase the efficiency of signal transmission.

In FOWLP, the chip is connected to the motherboard through RDL (Re-Distributed Layer) composed of polymer and conducting layers, which replaces PCB.

For the polymer layer, photosensitive dielectric material (PID, Photo Image-able Dielectric Polymer) is being widely used for fine pattern traces with smaller than 5um line and 5um space and via smaller than 20um in diameter. To make the fine pattern traces on photosensitive dielectric material considering the relationship between signal transmission and surface roughness, i.e. the skin effect, high adhesion strength between the conducting and dielectric layers of flatness surface is required.

To satisfy such needs, sputtering technique with Ti-Cu or Ni-Cu are generally being used. However in this study, the photo pre-treatment mechanism to obtain a very flat surface with high adhesion strength with the conducting layer will be studied.

Surface treatment with low pressure Hg lamp that with light emission of 184.9 nm and 253.7 nm and Xe based Excimer lamp with light emission of 172 nm was studied, as well as the relation to the adhesion strength between the surface and the conducting layer.

References:
2) Young-Jae KIM, Jong-Young PARK, Kwan-sun YOON, Joo-Hyong NOH, Hideo HONMA and Osamu TAKAI, Journal of Nanoscience and Nanotechnology, Vol. 16, 2016.11
Improvement of Corrosion resistance by Ca and Y addition in magnesium alloy

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AZ91D alloy is a cast magnesium alloy that is widely used due to its excellent castability and mechanical properties. Despite these advantages, the application range is not broad due to its low corrosion resistance. Many researchers are currently studying the corrosion resistance of magnesium alloys that are improved by process control, surface treatment, and development of new alloy. In recent years, my research team has developed new magnesium alloy, which has improved corrosion resistance and non-flammability by adding Ca and Y in AZ alloy. In this paper, corrosion behavior of this alloy was evaluated systematically in detail by changing the casting method and post treatment. The corrosion evaluation was carried out with AZ91 and SEN9 manufactured by die-casting and gravity-casting method, respectively. Salt spray test, immersion test and potentiodynamic test were done for corrosion test. In addition, AZ91D and SEN9 are coated by chemical conversion coating, electro-deposition or powder coating and plasma electrolytic oxidation. As a result of experiment, regardless of casting methods, SEN9 has better corrosion resistance than AZ91 alloy. And PEO + painting treated specimen showed enhanced corrosion resistance than any other finishing process.

Keywords: AZ91, Gravity casting, Die casting, Corrosion, Ca and Y addition
Scientists studied the physical, chemical properties of graphene, a two-dimensional (2D) layered materials, such as transition-metal dichalcogenides (TMDs), and the possibility of using these materials for variety of device, including field-effect transistors (FETs), sensor, memory, light-emitting diodes (LEDs), and photodetectors [1-2].

In particular, electronic devices based on semiconductors on layered 2D material forms have many advantages, compare with the conventional electronic devices based on Silicone technology, due to their ultra-thickness, low power consumption, chemical stability and low carrier scattering on their surfaces. In this abstract, we studied for the electronic properties of few-layered MoTe$_2$ FETs with various dielectric constant of silicon oxide (SiO$_2$) $\varepsilon = 3.9$, silicon nitride (SiN) $\varepsilon = 3 - 4$, and aluminum oxide (Al$_2$O$_3$) $\varepsilon = 9 - 10$. We fabricated field-effect transistors (FETs) based on few-layered 2D material (MoTe$_2$) on substrates (Ti / p-Si / 300nm of SiN, Al$_2$O$_3$, and SiO$_2$). The electrodes (Ti, 50 nm) deposited by Electron-Beam (EB) evaporation at room temperature on high-doped silicon substrates covered with various dielectric materials. The electrical characterization was carried out using Semiconductor Parameter Analyzer 4155-A (Hewlett Packard, USA). We observed 2D FETs performance by the subthreshold swing (SS) and effective mobility ($\mu_{\text{eff}}$) with different dielectric materials. The subthreshold swing (SS) is introduced to characterize the rate of increase of the drain current under the gate voltage and can be given by

$$SS = \frac{dV_g}{d(I_d)}$$

where $V_g$ is the gate voltage and $I_d$ is the drain current. The field-effect charge mobility was calculated using this equation

$$\mu_{\text{eff}} = \left(\frac{dI_d}{dV_g}\right) \times \frac{L}{W(C_i V_{ds})}$$

where $C_i$ is the gate capacitance calculated from the equation $C_i = \frac{\varepsilon_0 \varepsilon_r}{d}$. In his equation, $r$ is equal to 3.9 for the SiO$_2$. The thickness of the oxide is 300 nm, the gate capacitance is $1.15 \times 10^{-4}$Fm$^{-2}$ and $L$ and $W$ represent the channel length and width, respectively. Our findings provide an important role in furthering understanding of these materials and devices.

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REFERENCES
Surface Characteristics of Metallic 3D Printed Dental Products

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In this study, surface characteristics of metallic 3D printed dental products were researched using various instruments. For this study, two materials of Ti and Co-Cr were chosen for 3D printing (Metalsys150, Winforsys Co), and then materials were classified according to bulk and 3D printed specimens. Furthermore, 3D printed Co-Cr material was to be classified in 2 types; heat-treated and non-heat treated conditions. Ti and Co-Cr materials were subjected to a series of experiments for morphology, mechanical properties, biocompatibility, and corrosion properties and then compared in various conditions. Firstly, stress distribution and crystallite of metallic 3D printed surface was investigated by X-ray diffractometer. Secondly, elastic modulus and hardness were observed using the nano-indentation tester to compare the variation of mechanical property according to microstructure of the material before and after the heat treatment and with and without the 3D printing process. And then, finally, corrosion and biocompatibility tests were to be carried out to determine which materials were more suitable for the oral cavity.

In this study, we investigated the shape and treatment method more suitable for the oral condition by comparing the materials of the bulk state and the 3D printing state(hcchoe@chosun.ac.kr).

Keywords:
Co-Cr, Ti, Metallic 3D printing, Surface Characteristics, Mechanical Property, Corrosion

REFERENCES
Enhanced Electrical Conductivity of the Carbon Nanocoils using H₂-Plasma

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Free-standing carbon nanocoils were obtained using a thermal chemical vapor deposition process in which C\textsubscript{2}H\textsubscript{2} is used as the source gas and a few amount of SF\textsubscript{6} as an additive gas. C\textsubscript{2}H\textsubscript{2} as the source gas and SF\textsubscript{6} as the additive gas. Surface modification of the free-standing carbon nanocoils was performed by H\textsubscript{2}-plasma in a microwave plasma enhanced chemical vapor deposition system. The measurement of the electrical conductivity was carried out using four-point probe system in the measuring temperature range of 30~300°C. Indeed, the ambient state of the electrical conductivity measurement was varied as vacuum, H\textsubscript{2} gas or Ar gas environment at every measuring sample. The samples (less than H\textsubscript{2}-plasma treatment time 1min) show the decreased-resistivity with increasing the measuring temperature, indicating the semiconductor characteristics for the carbon coils and surface-modified carbon coils like the characteristics of multi-walled carbon nanotubes. Among the various carbon nanocoils, H\textsubscript{2}-plasma treated carbon nanocoils gave rise to the most high surface electrical conductivity in the measuring temperature range of 30~300°C. It is understood that the electron-conducting channels might be enhanced by H\textsubscript{2}-plasma treatment on the surface of the carbon nanocoils. H\textsubscript{2}-ambient environment also results in the enhancement of the surface electrical conductivity of the sample, compared with the other ambient state. Ar-ambient environment of the carbon nanocoils seemed to stabilize the values of the electrical conductivities. Based on these results, the cause for the enhancement of the surface electrical conductivity of carbon nanocoils by the surface treatment was suggested and discussed.