
November 21, 2011
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Program Director, Japan Science and Technology Agency
Critical Materials for Energy and Environment

Energy
Generation, conversion, storage

Solar Cell
Ga As In Cd Ru

Fuel Cell
Pt Rh La Ce Gd

Battery
Li Co Ni R.E.

Energy use
Heat, actuation, illumination, information

Thermo-Electric
Bi Te Co Sb

Motor
Dy Nd Sm Co B

LED
Ga In La Eu Y

Electronics
Ag Au Pd Rh In W

Catalyst
Pt Pd Rh R.E.

Research Institutes and Funding System in Japan

Ministry of Education, Culture, Sports, and Science and Technology (MEXT)

funding agencies
JST JSPS

RIKEN NIMS Universities

Strategic Research Basic Research

Ministry of Economy, Trade and Industry (METI)

funding agency
NEDO

Industry

AIST

Applied Research
"An elemental strategy project"
"Rare metal substitution material development project "
(MEXT & METI)

**MEXT**

*An elemental strategy project*

- **Target**: Rare and harmful elements
- **Basic Research**
  - Drastic substitution
  - Vast reduction of consumption amount
- The proposal of the new paradigm of Material Research

**METI**

*Rare metal substitution material development project*

- **Elements which need urgent provisions such as**
  - In, Dy, W, Pt, Tb, Eu, Ce
- **Aim**: 30~80% Reduction
- The promotion of Research Development

Joint adoption, Joint symposium, Joint session of shared research equipment and etc.

- Examination of developing METI project at a point of time when the assignment ends in 5 years
- Setting the numerical target of reduction amount
  - Aiming to reach to the sample level
MEXT — JST

Project
Background
- Rare resources, represented by rare earth and other rare metal elements which are being utilized for the advanced industries such as electronics, automotives, information technologies, robots, etc., are facing their price increase and tight supply due to rapid increase of their consumptions and producing countries’ resource management policies accompanying with the global economic growth and advanced industries’ expansion.
Project Outline

- This project started in 2007 aiming at the establishment of fundamentals on roles of material’s elements responsible for the material properties and the development of alternative materials substituting rare metals and rare earth elements by ubiquitous and nonhazardous ones.

- Research subjects which see their paving ways for their practical stages are expected to explore opportunities for further development by applied research funding programs after their accomplishment.
## An elemental strategy project: in FY2007

<table>
<thead>
<tr>
<th>No.</th>
<th>Subject of research</th>
<th>Research leader/Adoption entrepreneur</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>Development of Hot-dipped Aluminum Alloy Coated Steels</td>
<td>Toru Tsuru, Tokyo Institute of Technology</td>
</tr>
<tr>
<td>2</td>
<td>Development of the next-generation nonvolatile memory using anodized aluminum film</td>
<td>Giyuu Kido, National Institute for Materials Science (NIMS)</td>
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<tr>
<td>3</td>
<td>The new function which hydrogen induces in subnano lattice substance</td>
<td>Masuo Okada, Tohoku University</td>
</tr>
<tr>
<td>4</td>
<td>Self-forming Nano-particle Catalyst without Precious Metals</td>
<td>Yasuo Nishihata, Japan Atomic Energy Agency</td>
</tr>
<tr>
<td>5</td>
<td>Development of Barium-based New Lead-free Piezoelectric Materials with Ultrahigh Piezoelectric Property for Piezoelectric Frontier</td>
<td>Satoshi Wada, University of Yamanashi</td>
</tr>
<tr>
<td>6</td>
<td>Development of TiO2-based Transparent Electrode</td>
<td>Tethuya Hasegawa, Kanagawa Academy of Science and Technology (KAST)</td>
</tr>
<tr>
<td>7</td>
<td>High Performance Anisotropic Nano composite Permanent Magnets with Low RareEarth Content</td>
<td>Satoshi Hirosawa, Hitachi Metals</td>
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<tr>
<td>1</td>
<td>Material Design and Processing of Highly-Dispersed Catalysts with Minimum Precious Metal Loadings</td>
<td>Masato Machida Kumamoto University</td>
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<tr>
<td>2</td>
<td>Nano-hybridized Precious-metal-free Catalysts for Chemical Energy Conversion</td>
<td>Kohei Uosaki Hokkaido University</td>
</tr>
<tr>
<td>3</td>
<td>Development of Innovative Energy Conversion Systems with Molecular Catalysts Replacing Precious Metals</td>
<td>Yoshinori Naruta Kyushu University</td>
</tr>
<tr>
<td>4</td>
<td>Ubiquitous Element Strategy for Function Emergence</td>
<td>Hideo Hosono Tokyo Institute of Technology</td>
</tr>
<tr>
<td>5</td>
<td>Functional design by precise synthesis of silicon oxide compounds</td>
<td>Kazuyuki Kuroda Waseda University</td>
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<td>1</td>
<td>Design and Processing of Functional Materials with Multi-elements Based on Chemical Potential Diagrams</td>
<td>Tetsuya Uda Kyoto University</td>
</tr>
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<td>2</td>
<td>Organic Molecular Approach to High-performance secondary Batteries and Mechanistic Elucidation of Charge-discharge Processes</td>
<td>Yasushi Morita Osaka University</td>
</tr>
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<td>3</td>
<td>Development of the platinoid-elements free functional magnetic material by compound interface control</td>
<td>Eiji Kita University of Tsukuba</td>
</tr>
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<td>4</td>
<td>Development of Eco-friendly Post Lithium-ion Batteries</td>
<td>Shigeto Okada Kyushu University</td>
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New Projects of MEXT (2011)

Crest
PD. Prof. Tamao

さきがけ
PD. Prof. Hosono
Independent Administrative Institution
National Institute for Materials Science
— The only national lab dedicated to materials science in Japan —

1. Fundamental and innovative research on materials science
2. Promotion of widespread use of research results and applications
3. Shared use of advanced research facilities
4. Cultivation of researchers in the materials science discipline

Budget : $200 million (Subsidy : from MEXT $150M)
Personnel : 450 Scientists, 100 staffs
500 visiting researchers
# NIMS Organization (2011/4/1)

## Environment and Energy Materials Division
- Environmental Remediation Materials Unit
- Battery Materials Unit
- Superconducting Wires Unit
- Superconducting Properties Unit
- Photovoltaic Materials Unit
- Optical and Electronic Materials Unit
- Materials Reliability Unit
- Hydrogen Materials Unit
- Magnetic Materials Unit
- High Temperature Materials Unit
- Hybrid Materials Unit
- Sialon Unit

## International Center for Materials Nanoarchitectonics (MANA)
- Soft Chemistry Unit
- Nanotubes Unit
- Supermolecules Unit
- Inorganic Nanostructures Unit
- Nano-Electronics Materials Unit
- Nano-System Organization Unit
- Nano Functionality Integration Unit
- Atomic Electronics Unit
- Nano-System Theoretical Physics Unit
- \(\pi\)-Electron Electronics Unit
- Nano Interface Unit
- Soft Ironics Unit
- Nano Photocatalyst Unit
- Reticular Materials Unit
- Sustainability Materials Unit
- Biomaterials Unit
- Tissue Regeneration Materials Unit

## Advanced Key Technologies Division
- Nanotechnology Science Unit
- Materials Processing Unit
- Photonic Materials Unit
- Polymer Materials Unit
- Quantum Beam Unit

## Research Center for Strategic Materials
- Structural Materials Unit

## Research Network and Facility Services Division
- Global Research Center for Environment and Energy based on Nanomaterials Science
- Center of Materials Research for Low Carbon Emission
- Materials Information Station
- Materials Manufacturing & Engineering Station
- Transmission Electron Microscopy Station
- High Magnetic Field Station
- NIMS Beamline Station at Spring-8
- Materials Analysis Station
- Nanotechnology Innovation Station
- NIMS-Leica Bio-imaging Laboratory
- NIMS Office at EMPA

## External Collaboration Division
- Research Collaboration Office
- Academic Collaboration Office
- NIMS-TOYOTA Materials Center of Excellence for Sustainable Mobility
- NIMS Saint-Gobain Center of Excellence for Advanced Materials
- Tsukuba University Liaison Office
A new center on elements science and technology at NIMS from FY2011

- Designing permanent magnets with elements science
  - Micro-, Nano-, Atomic-scale characterization of materials—understand roles of alloying elements

- Rare metal free structural materials
  - Steel, Mg-alloy, Ti-alloy, Stainless-steel,
  - Hierarchical control of metallic texture
  - Innovative process techniques to improve properties

- Catalyst, reducing critical elements (Pt, Pd…)
  - Introducing active atoms into inter-metallic alloy
  - Morphology control in nano-scale

- Separation and aggregation Techniques of critical elements
  - From the Urban Mines
  - Mesoporous materials precisely modified pore accuracy
MEXT — NEDO

Project
## Rare metal substitution material development Project: in FY2007

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<th>Subject of research</th>
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<tr>
<td>Development of Technology to Reduce Indium Use in Transparent Conducting Electrodes</td>
<td>Takashi Nakamura</td>
<td>IMRAM, Tohoku University</td>
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<tr>
<td>Development of Technology to Reduce Dysprosium Use in Rare Earth Magnets</td>
<td>Satoshi Sugimoto</td>
<td>Tohoku University</td>
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<tr>
<td>Development of Technology to Reduce Tungsten Use in Cemented Carbide Tools</td>
<td>Keizou Kobayashi</td>
<td>AIST</td>
</tr>
<tr>
<td>Development of Substitute Materials for Tungsten in Cemented Carbide Tools</td>
<td>Hayashi Koji</td>
<td>AIST Japan Fine Ceramics Center (JFCC)</td>
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</tbody>
</table>
## Rare metal substitution material development Project : in FY2009

<table>
<thead>
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<th>Subject of research</th>
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<tbody>
<tr>
<td>Pt</td>
<td>Development of Technology to Reduce Platinum Group Use by Utilizing Substitute Transition Elements and Aggregation Inhibitor of Platinum Group</td>
<td>Sekiba Toru</td>
<td>Nissan Motor Co., Ltd</td>
</tr>
<tr>
<td>Pt</td>
<td>Development of Technology to Reduce Platinum Group Use in Catalysts for Diesel Exhaust Emission</td>
<td>Hideaki Hamada</td>
<td>AIST</td>
</tr>
<tr>
<td>Ce</td>
<td>Development of Technology to Reduce Cerium Use for Precision Polishing by Utilizing the Substitute Abrasive Grains and Innovative Polishing Technology</td>
<td>Seiiti Suda</td>
<td>Japan Fine Ceramics Center (JFCC)</td>
</tr>
<tr>
<td>Ce</td>
<td>Development of Technology to Reduce Cerium Use by Utilizing the Concept of 4BODY Polishing Technology</td>
<td>Yasuhiro Tani</td>
<td>Ritsumeikan University</td>
</tr>
<tr>
<td>Tb Eu</td>
<td>Development of Technology to Reduce Terbium and Europium Use in Fluorescent Materials for Lamps by Fast Synthesis and Characterization Method</td>
<td>Tomoko Akai</td>
<td>AIST</td>
</tr>
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</table>
Next generation Science and Technology on Elements Project

- **Budget Proposal**
  - 10 years project
  - 4 hubs in Japan
  - Several million € per each hub

- **Electron Theory Group**

- **Design Group with Quantum Theory**

- **Fabrication Group with Nano Construction**

- **Science Based Alternative technology**

- **Analysis and Evaluation Group of Material Function**

- **Nano Fabrication Group**

- **Function Analysis Group**

- magnet
- catalyst
- electronic
- structural
- Etc.
Summary

✓ Japan is promoting the national scheme for Critical Raw Materials

✓ International cooperation is important for more innovative technology, in addition to collaboration between industries, universities, and national institutes.

✓ Technology is only applicable when it is based on the true science.

✓ Robust Japan-EU collaboration will be expected in the fundamental and pre-competitive research area.

... Let’s Collaborate!