“Memories of Norman Rostoker and UCI Physics Dept 1970-85”

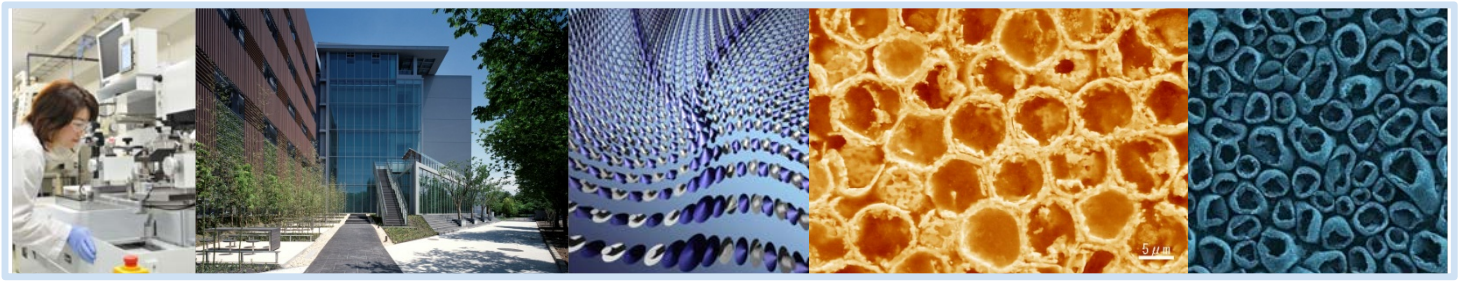
Sukekatsu Ushioda
President
National Institute for Materials Science
Tsukuba, Japan

Relation to Norman Rostoker

- I was a junior faculty member of Physics Dept. when NR arrived
- Famous plasma theorist coming--Kohn-Koringa-Rostoker Green Function
- Strong and unique sense of humor
- Very clever Tennis player
- Billiard games to earn scholarship
- Undergraduate teaching
- Collaboration with Toshi Tajima—solid plasmon amplification
- Fast electron through crystal lattice—X-ray radiation?
- Various memories of the Physics Department during 1970-1985
- Viet Nam War and peace movements

Life after UCI

- After leaving UCI to Japan
- Professor Tohoku University, Sendai, Japan
- President, Japan Advanced Institute for Science and Technology
- President, National Institute for Materials Science



NIMS Overview

National Institute for Materials Science (NIMS)

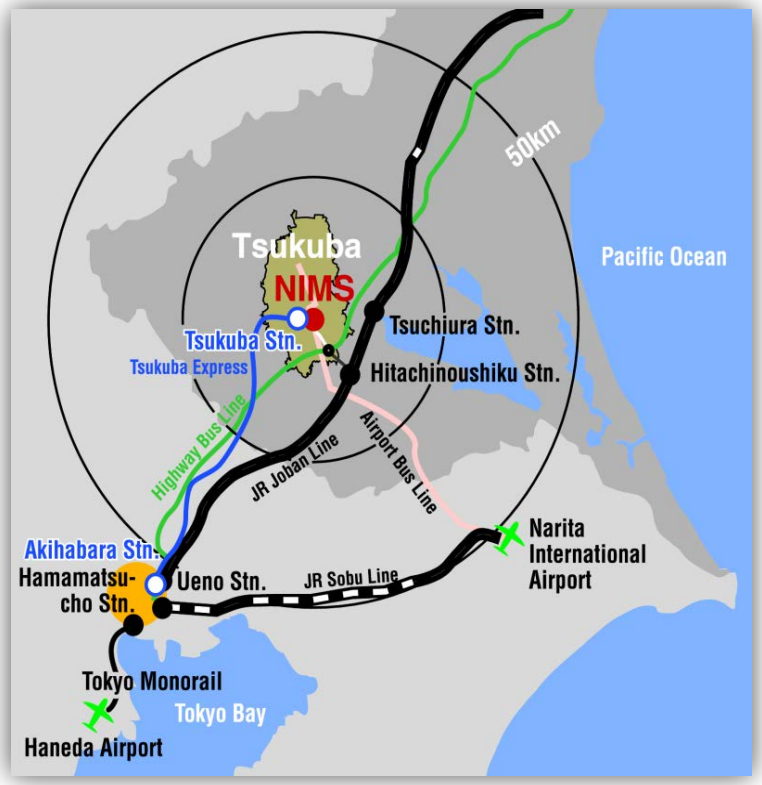
http://www.nims.go.jp/eng/index.html

Tsukuba Science City

History of Tsukuba Science City

… there used to be an empty/wilderness space

1963 Planning started
1970 Groundbreaking
1972 First building of NIMS
1985 Tsukuba Science Exposition (Completion Ceremony)

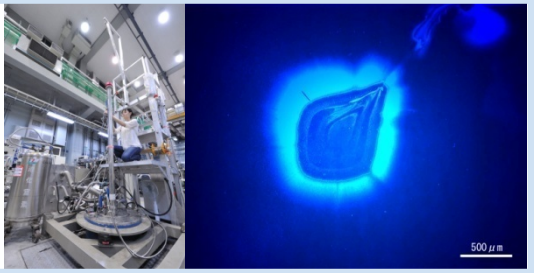


Tsukuba Science City now …

a city for high-tech. academic and industrial institutes

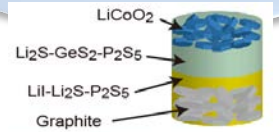
-300 institutes, including Univ. of Tsukuba, AIST, NIMS,…
-13,000 researchers (5,600 PhDs)

NIMS Research Portfolio & Main Research Themes

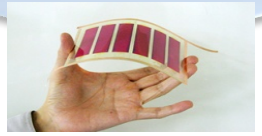


Energy and Environment Technologies

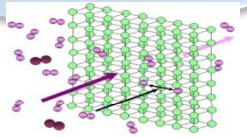
Solid-state Lithium Batteries



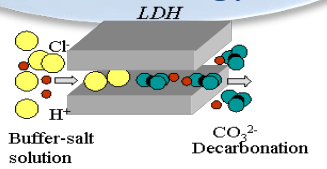
Photovoltaics Technology



Hydrogen Production Technology



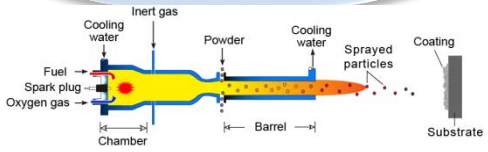
Environmental Remediation Technology



Superconductive Technology

High Power Magnetic Technology

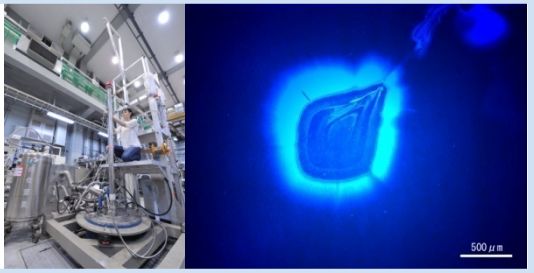
Coating Technology



Reliability & Safety Technology

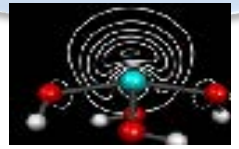
Heat Resistance Technology

NIMS Research Portfolio & Main Research Themes

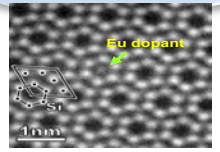


Advanced Key Technologies

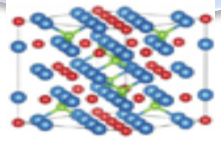
- Photonic Materials Technology
- Computational Materials Science



- Surface Physics and Structure



- Advanced Characterization Technology



- Organic Material Synthesis Technology

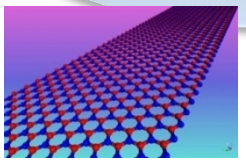
- Advanced Quantum Beam Technology

NIMS Research Portfolio & Main Research Themes

Nano Scale Technologies (MANA)

Nano Revolution for the Future

Nano-Materials Technology

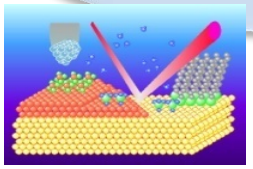


- Soft Chemistry
- Nanotubes
- Nano-Electronics
- Supermolecules
- Inorganic Nanostructures

Nano-System Technology

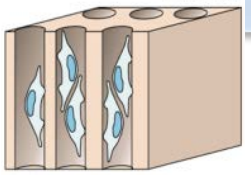
- Atomic Electronics
- Nano Functionality Integration
- Theoretical Physics
- π-Electron Electronics

Nano-Power Technology



- Nano Interface
- Nano Photocatalyst
- Soft Ionics
- Reticular Materials

Nano-Life Technology



- Biomaterials
- Tissue Regeneration Materials

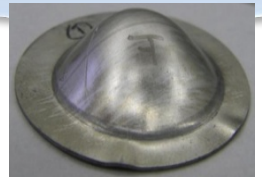
＊ : International Center for Materials Nanoarchitectonics

NIMS Research Portfolio & Main Research Themes

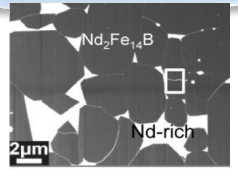
Natural Resources Technologies

High performance technology without rare earth/rare metals is aimed not only for functional materials of magnet and catalyst but also for structural materials of vehicles and bridges.

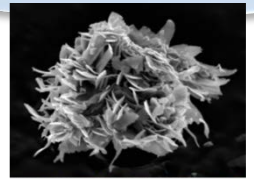
RE-free Wrought Mg Alloy



Dy-free Ne-Fe-B Magnet



Long-life Exhaust Catalysts for Vehicles



Structural Materials

Research Center for Strategic Materials

Saving natural resources and critical materials

High performance without rare metals:

Functional materials for magnets and catalysts
Structural materials for vehicles, buildings, bridges, etc.

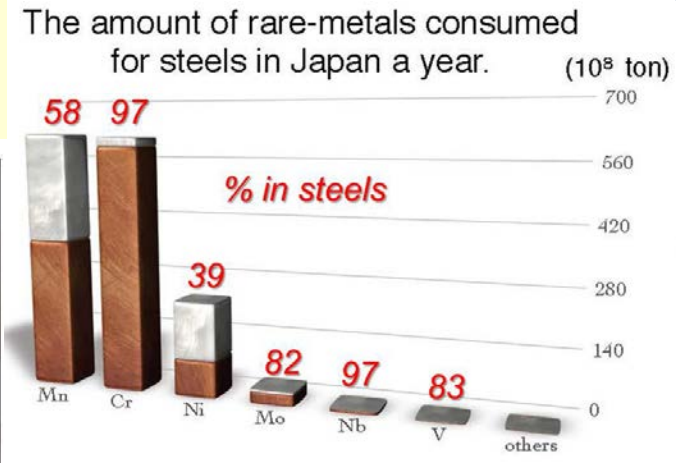
Exhaust catalyst per car

0.5 g Pt

functional materials

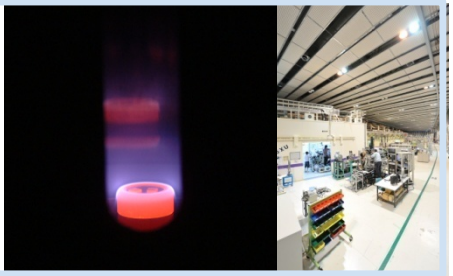
Body per car
700 kg Steel (0.2% Mn)

1400 g Mn



structural materials

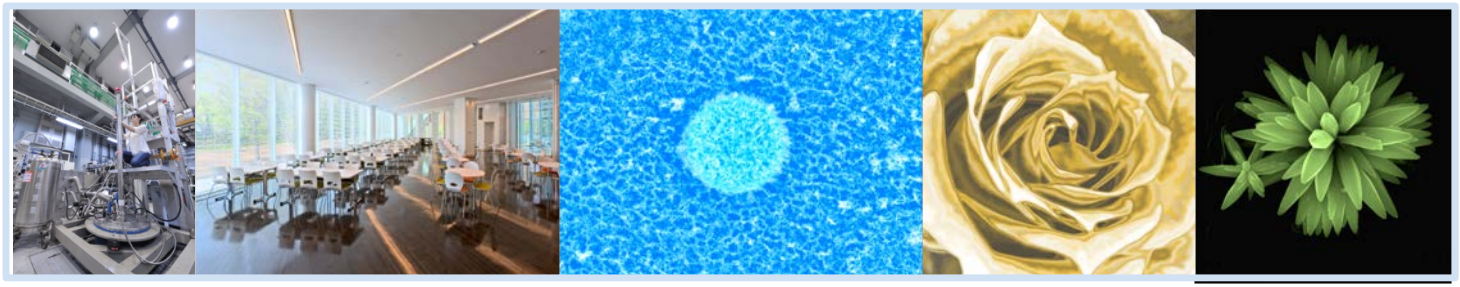
People Working at NIMS



Classification	Number
Executives	**6**
Research Groups	**1,141**
Tenure Researchers	397
Invited Researchers	21
Special Researchers	63
Postdoctoral Researchers	203
Junior Researchers	2
Engineers	86
Technicians	279
Non- Research Groups	**364**
Administrative Staff	329
Specialized Professions	35
Total	**1,511**

April 1, 2015

Country	Number	Country	Number
Australia	1	Pakistan	3
Bangladesh	2(1)	Philippines	3
Belgium	1	Poland	1
Canada	3(2)	Romania	2
China	134(17)	Russia	9(3)
Czech	3	Singapore	1
Egypt	2(1)	Spain	3(3)
France	4	Sri Lanka	1
Germany	6	Switzerland	1(1)
Greece	1	Taiwan	2
Ireland	1	Thailand	1(1)
India	38(2)	UK	3(2)
Indonesia	9	Ukraine	1(1)
Iran	4(1)	USA	2
Korea	20(3)	Vietnam	3
Morocco	1		
Myanmar	1		
Netherlands	2(1)		
Nepal	3(1)	Total	272(40)

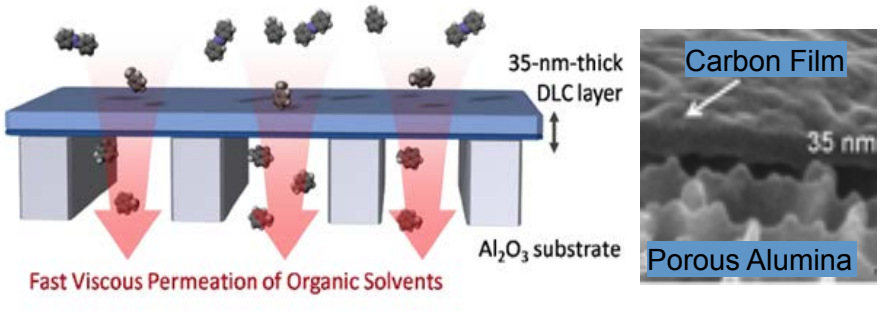


High Light of Our Research Products

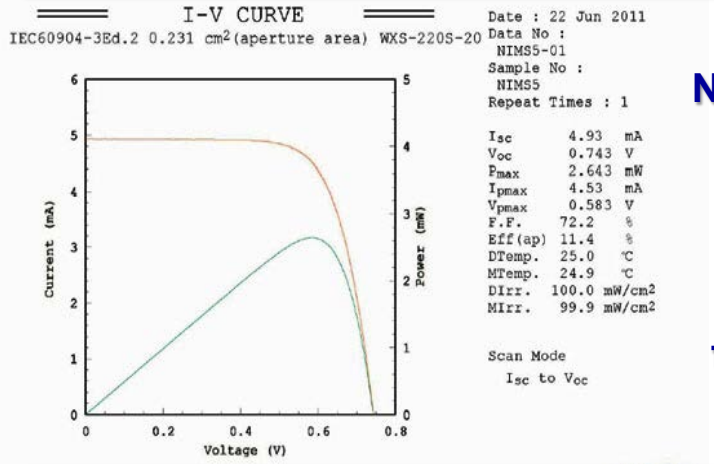
National Institute for Materials Science (NIMS)

Latest Research Topics

High Performance Filtration Membranes Enabling Oil Purification



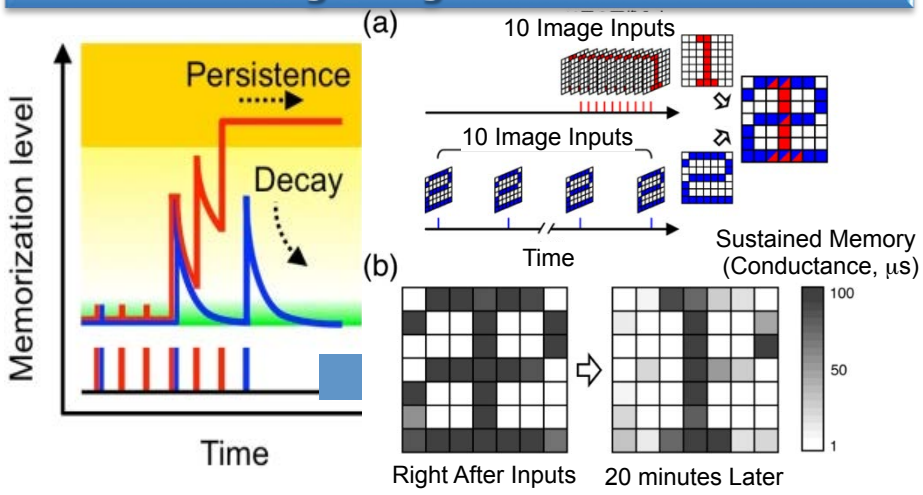
World Record for Conversion Efficiency of Dye-Sensitized Solar Cells



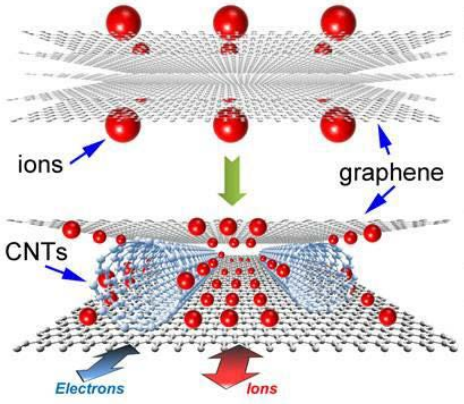
Innovative New Additive Materials

Improved Efficiency from 11.1% to 11.4%

New Brain-type Device, Memorizing and Forgetting like Human



High Capacity Graphene-Based Supercapacitors



Stored Energy Density

10 ~ 30 Wh/kg

155.6 Wh/kg

SiAlON Fluorescent Material with High Brightness and High Efficiency

R&D Impact

Durable phosphors have been developed by introducing the luminescent ions such as Eu into the crystal of SiAlONs.

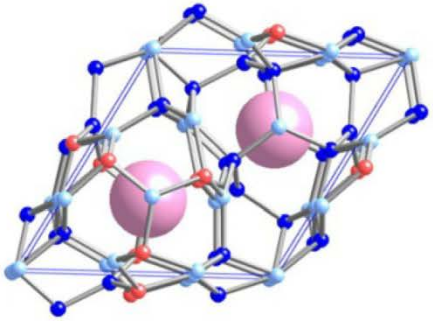


Fig.1 SiAlON crystals

Red: $CaAlSiN_3$

Fig.2 SiAlON Phosphor

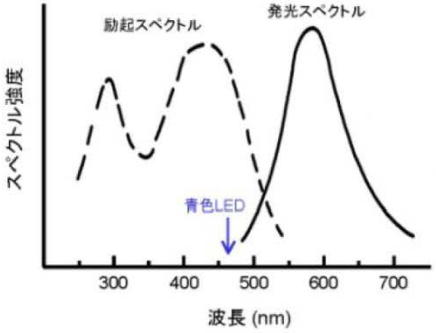


Fig. 3 Luminescence property

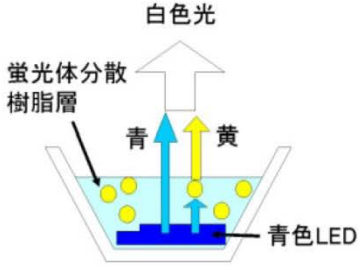


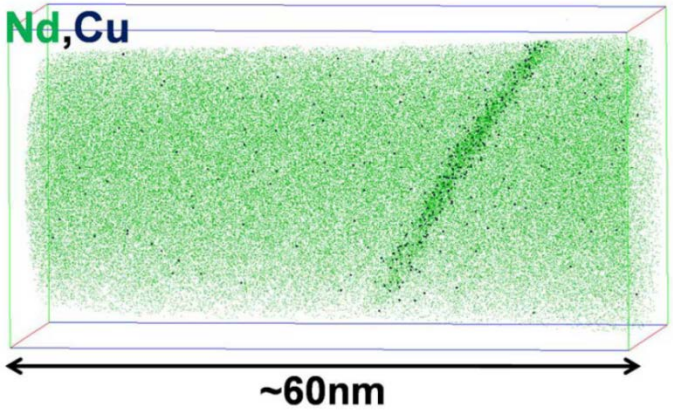
Fig.4 Principle of white LED

- **Superior in durability and high temperature stability**
- **Excitation of green and red (+ yellow) phosphors by blue LED**
- **Original materials of NIMS and possession of fundamental patents (12 patents)**

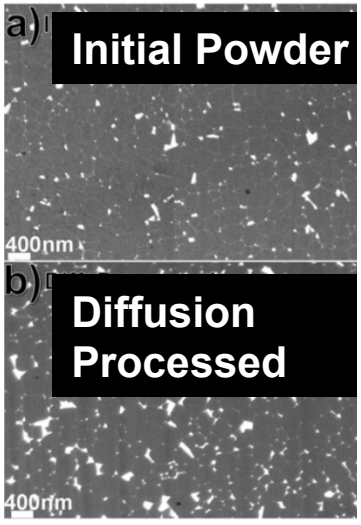
Neodymium Magnet without Dysprosium

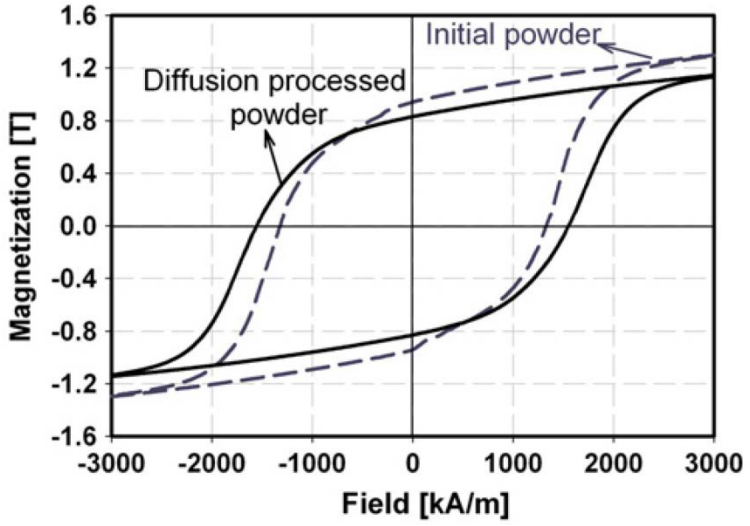
R&D Impact

- **Method for increasing the coercivity of neodymium magnet powder without using dysprosium**
- **Thickening of the Nd-rich grain boundary phase could be attributed to the coercivity enhancement.**



3DAP map of Nd and Cu of the diffusion processed sample





Scripta Materialia, 63, 1124 (2010)

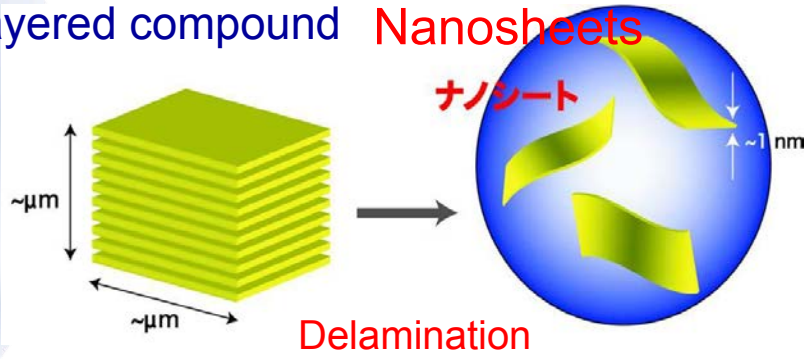
- The systematic nanostructure analysis of existing neodymium magnets using 3D Atom Probe reveals that the coercivity can be improved by decoupling the ferromagnetic interactions between the crystal grains.

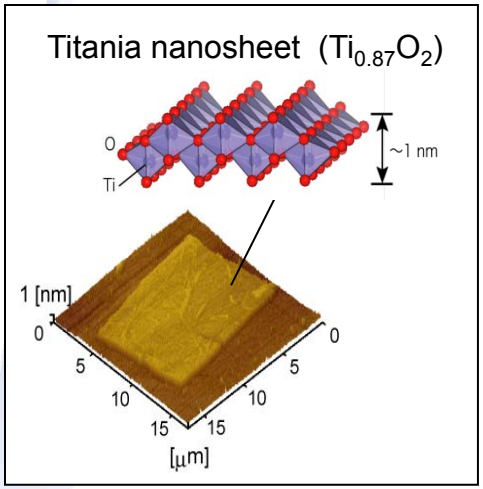
High- κ Dielectric Nanosheet

R&D Impact

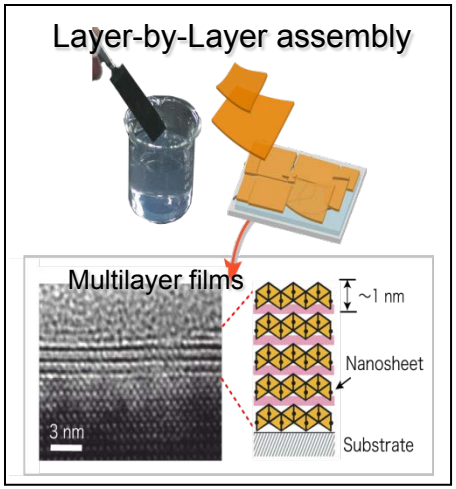
A novel fabrication process of titania nanosheets have been developed. These nanosheets exhibit high dielectric constants (κ ~125), even for thicknesses down to 10 nm.

Layered compound



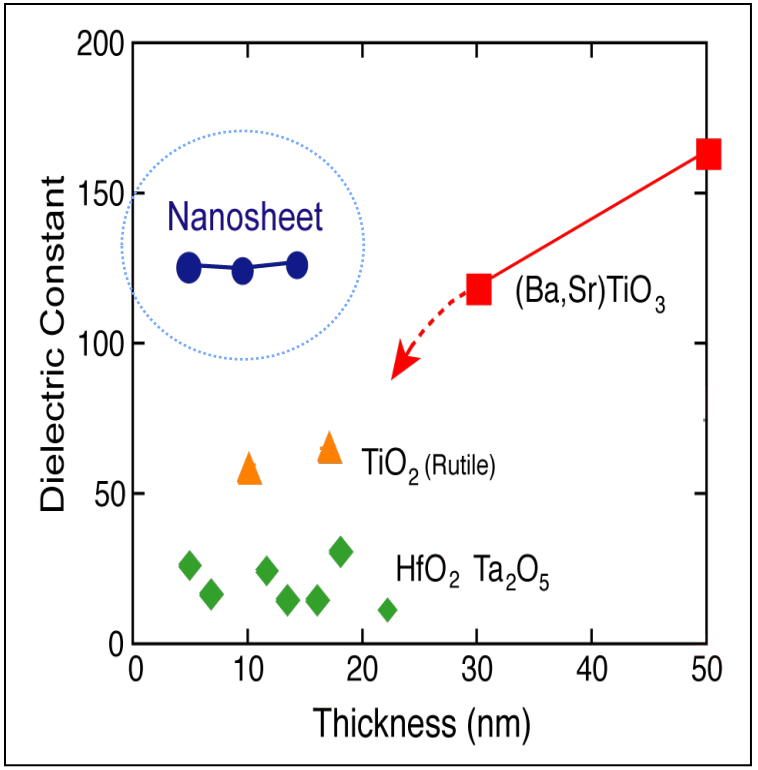


New candidate for high-κ material



Solution-based bottom-up fabrication

High-κ in nanoscale capacitors



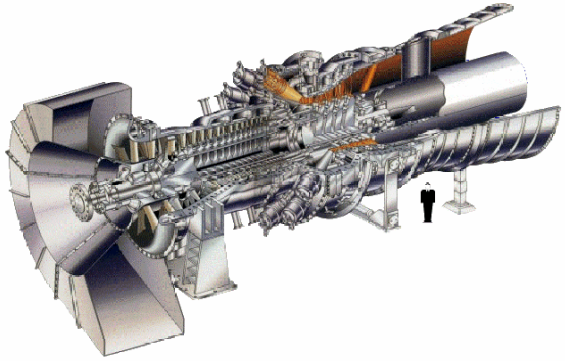
Applications to Future high-κ devices

Super Refractory Materials

R&D Impact

- Ni-based single crystal super alloy.
  (Usable temperature of 1100C has been achieved.)
- ‘Rolls-Royce Aerospace Materials Center’
  has been established within NIMS

Turbine blade



Gas turbine

Jet engine

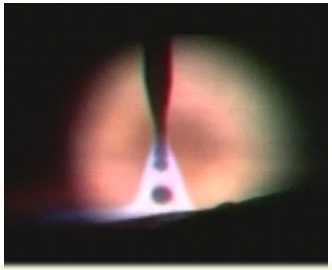
Social Infrastructure Structural Materials (Recovery and Rebirth from the Disaster)

Structural materials for safer social infrastructure

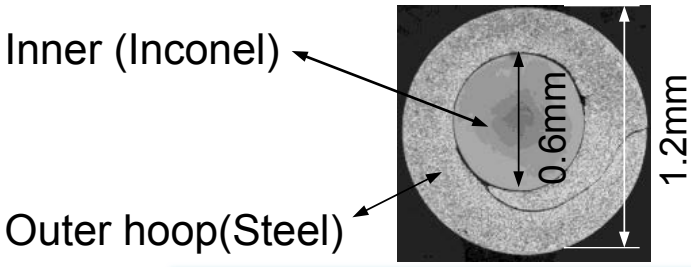
Ultra-high-strength bolts

Weathering steels
(atmospheric corrosion resistant)

Welding technologies & materials

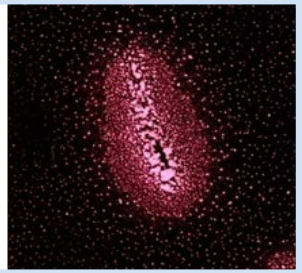


Ar-MIG welding



Double-walled welding wire

International Education/Invitation Programs



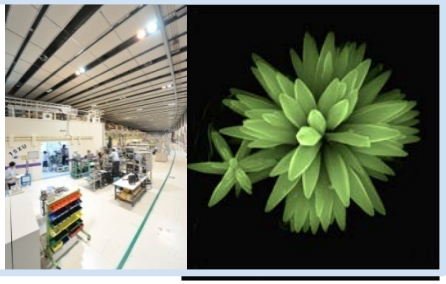
1. International Cooperative Graduate School Program
2. Internship Program
3. ICYS Research Fellow Program
4. Overseas Researcher Invitation Program (Invitation)

Ninomiya House (completely furnished with English speaking staffs)

Single Room

Academic Research Partners

(Inter-Institutional MOU)



25 Countries and Region
51 Agreements

under Comprehensive Collaborative Agreement (CCA)

UK (3)
Univ. College London
Univ. of Cambridge
Loughborough Univ.

FRANCE (4)
CNRS, CNRS Sant-Gobain
Univ. of Rennes 1
Ecole des Mines Paris

GERMANY (2)
Max Planck Inst. for Intelligent Sys.
Forschungszentrum Karlsruhe GmbH

SLOVAKIA (1)
Academy of Science

CANADA (1)
WIN-Univ. of Waterloo

NETHERLANDS (1)
NanoNextNL

SWITZERLAND (2)
EMPA
ETHZ

RUSSIA (1)
Lomonosov
Moscow State Univ.

MONGOL (1)
MUST

NEPAL (1)
Academy of Sci. & Tech.

ALGERIA (1)
DGRSDT

KOREA (6)
KRICT, KRISS, KIMS
KIST, KICET, KAIST

QATAR (1)
QATAR Foundation

USA (7)
Northwestern Univ.
North Caroline State Univ.
CNSI-UCLA, UCSB
MSEL-NIST, LRSM-Upenn
TMI-Temple Univ.

Indonesia (1)
ITB

MALAYSIA (1)
UTM

CHINA (4)
Xi'an Jiaotong Univ.
Nanjing Univ.
Inst. of Metal Res., CAS
Inst. of Physics, CAS

SPAIN-PORTUGAL (1)
Int'l Iberian Nanotech. Lab.

TAIWAN (5)
MOST, ITRI
National Taiwan Univ.
Nat'l Chiao Tung Univ.
Academia Sinica

VIETNAM (1)
IMS-VAST

BRAZIL (1)
CAPES

INDIA (2)
IT-BHU,
NEERI

ITALY (1)
Univ. of Rome tor Vergata

THAILAND (1)
NSTDA

NEW ZEALAND (1)
Univ. of Auckland

AUSTRALIA (1)
NSW Government

Academic Research Partners
(under Research Contract)

16 Overseas (★: 4 Joint Research Centers)
46 Domestic

as of October 1, 2014

UK (2)
Univ. of Cambridge
UCL

GERMANY (1)
Max-Planck Institute

KOREA (1)
KIMS

Japan (46)
Tokyo Univ.
AIST, JAXA,
etc.

USA (3)
UCLA
Georgia Tech.
Northwestern Univ.-NIMS
Joint Research Center
(2012)

CHINA (1)
Tianjin Univ.-NIMS
Joint Research Center
(2011)

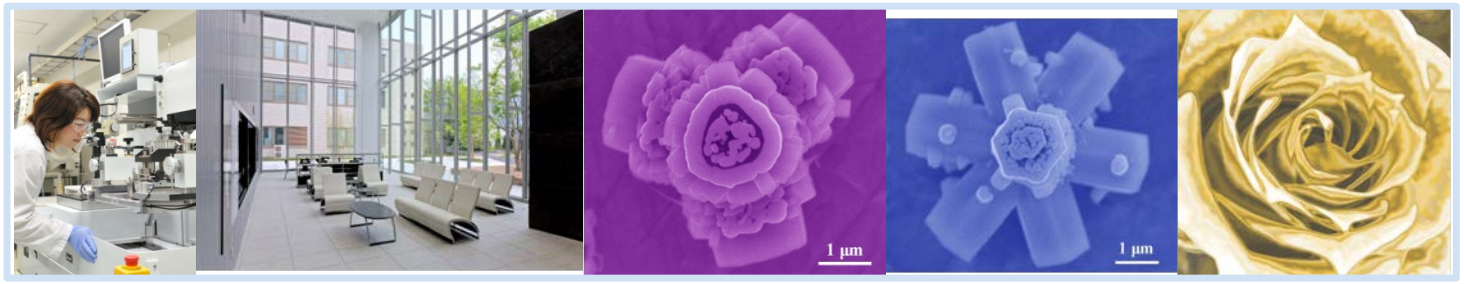
Taiwan (1)
SMART Center
(with NTU)
(2013)

FRANCE (3)
CNRS
ICMCB/CNRS
Grenoble-NIMS
Innovation for Advanced New
Technology (with GIANT)
(2014)

Thailand (2)
NANOTEC (e-ASIA)
MTEC (e-ASIA)

Malaysia (1)
Swinburne Univ.
of Technology

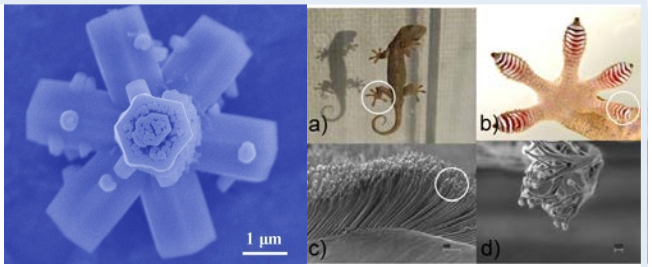
Vietnam (1)
IMS (e-ASIA)



Industrial Collaboration and Technology Transfer

National Institute for Materials Science (NIMS)

NIMS Offers a Variety of Technology Transfer



- Technical Consultation
  - Technology Transfer to Small Enterprises
  - Consultation to Local Industrial Partners
- Licensing
  - Patent License
  - Know-How License
- Sponsored Research
  - NIMS Sole Research Sponsored by Collaborator
- Membership Collaboration
  - NOiCS NIMS OPEN INNOVATION CENTER
- Collaborative Research
  - Individual Collaboration
  - Organized Collaboration
- Sample Evaluation
  - For Licensing Intellectual Properties
  - For Research Collaboration

NCoE NIMS CENTER OF EXELLENCE

Bilateral Industrial Collaboration
(Strategic Partners)

Membership Collaboration
(NIMS Open Innovation Center)

NOiC NIMS OPEN INNOVATION CENTER

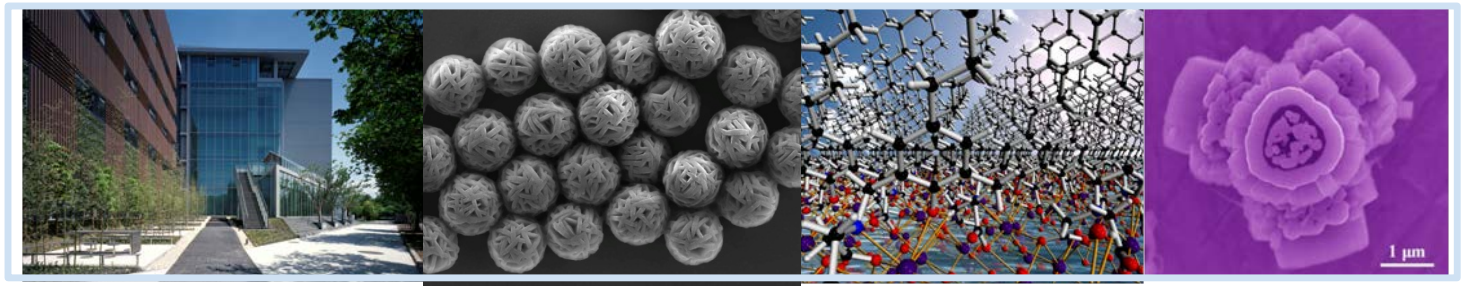
Industrial Members (12)

as of April 1, 2014

HITACHI Inspire the Next
SHOWA DENKO
Empowered by Innovation NEC
DIC
JX Nippon Mining & Metals
DENSO
DENKA
SAMSUNG
TAIYO YUDEN
ARS
MITSUBISHI CHEMICAL
LG

Academia Members (4)

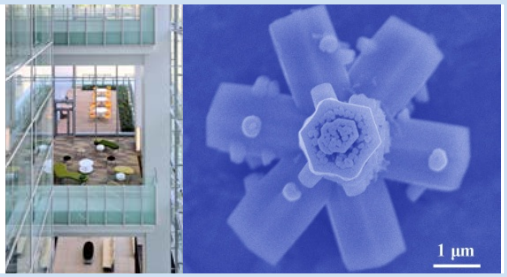
University of Tsukuba
National Institute of Advanced Industrial Science and Technology AIST
imec
HIROSHIMA UNIVERSITY

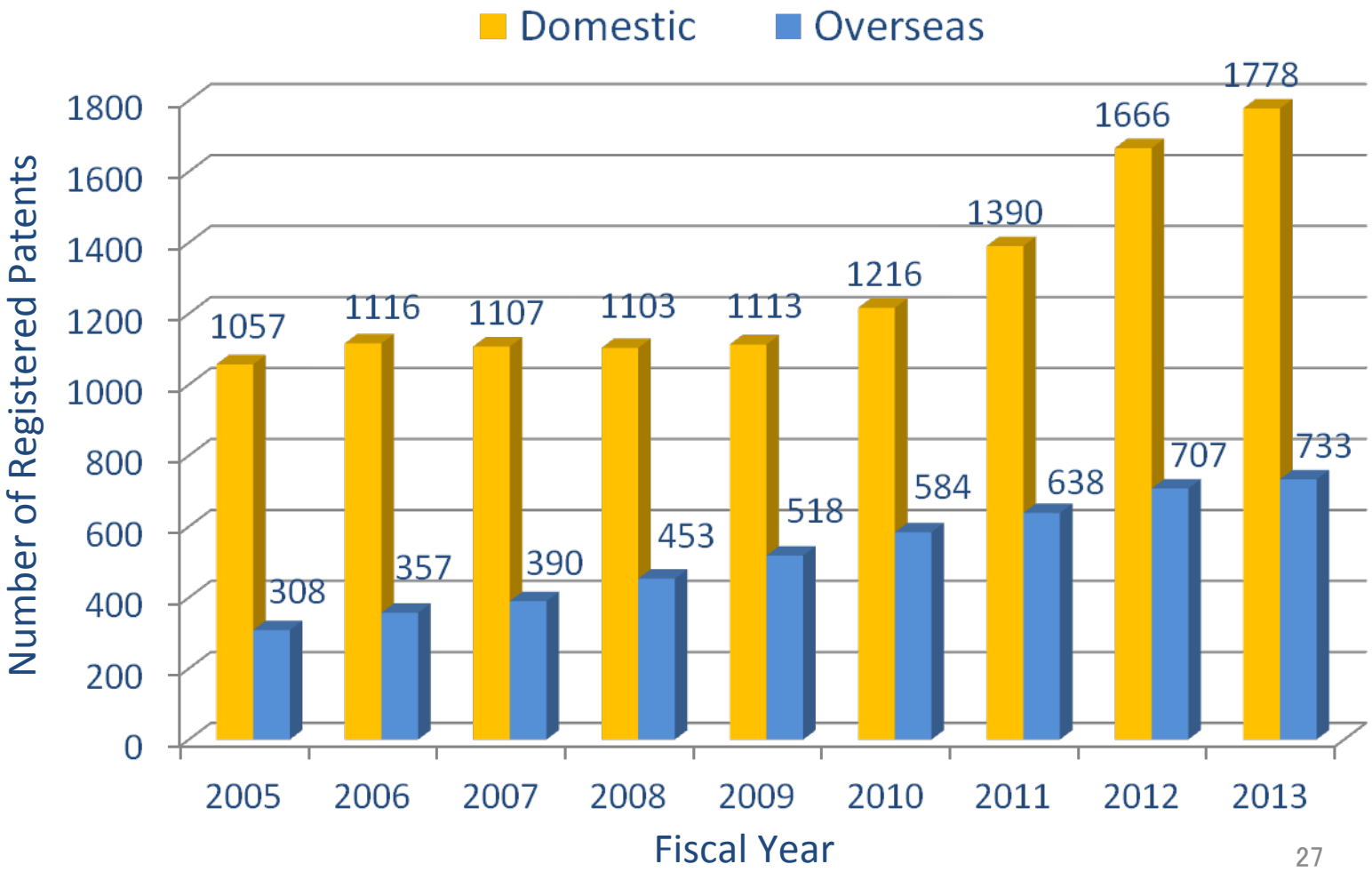


Intellectual Property and Licensing

National Institute for Materials Science (NIMS)

Accumulated Registered Patent Trend





Thank you

We, NIMS, are looking forward to a mutually fruitful collaboration with.

Thank you
for your kind attention!