ENVIRONMENT AND PROCESS DESIGN LABORATORY

長岡技術科学大学 Nagaoka University of Technology

Environment and Process Design Laboratory

Mechanical Engineering

Nagaoka University of Technology

Nano second and Nanometer Technology Research Group

Extreme Energy-Density Research Institute (EDI)

Labo Guide 2017 ver 1.0

We will support and welcome the foreign students. Please come on for study the World Advanced Manufacture and Environmental Engineering!!!

Thank you for downloading this file. What follows is an introduction to the Prof. Nakayama's groups for the Mechanical Engineering course at Nagaoka University of Technology.

■Areas of study

The areas studied by these Laboratories are truly wide-ranging. In brief, the Laboratories "seek to take up the challenge of a series of processes starting with assembling new electrical circuits that the world has never seen, constructing new power supplies, fabricating new devices to synthesize materials using those circuits and power supplies, measuring the properties of newly created materials that the world has never seen and analyzing their structure, and eventually putting those devices and materials into practical use."

Naturally, all of the work from designing an electrical circuit to putting it into practical use cannot be done by a single person. Once you are assigned to a Laboratory, your research topic will be determined upon consultation with the Laboratory Director, but we encourage you to work on what you excel at or what you would like to work on. **The Laboratories offer an overall view of the steps in R&D as part of "*Environmental Technology*" and "*Manufacturing*" so the Laboratories will allow you to see your own research results take shape.** In some instances, research results may be turned into an actual commercial product that makes it to market (like results put to practical use in the tactile sensors in the head of Sony's Aibo robot).

■KeyWords

Environmental Technology

CO_2 zero society, CO_2 zero manufacturing, Energy conversion and storage, Environment purification technology, Recycling, Reuse, Low environmental load process, Energy saving technology, Energy harvesting, Thermal management, Solar cell, Fuel cell, Heat storage technology

Manufacturing

Ceramics, Nanotechnology, Industrie 4.0 (Industry 4.0), IoT, Society 5.0, Devices for Robots, "unique technologies", 3D printer, New process development, Pulse power, Nanosecond technology, Construction method

System Design

Innovation, Big data, Development of AI (artificial intelligence) technology to manufacturing, Business model proposal, Production of complex systems such as automobiles and aircraft, Manufacturing by society, Production of "unique technologies", Robot Technologies (System, Sensor, Materials, Devices,,)

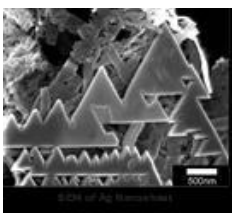
■Examples of recent research topics

■*Nano Pulsed Power Supply* Circuit design and process development

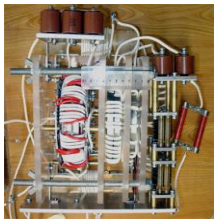
Synthesis of surface potential-controlled nanoparticles with plasma at atmospheric pressure using an originally designed nanosecond pulse power supply
(Involved power supply design and materials design)

Development of a plasma-assisted atomic layer deposition technique using a nanosecond pulse power supply
(Involved power supply design and materials design)

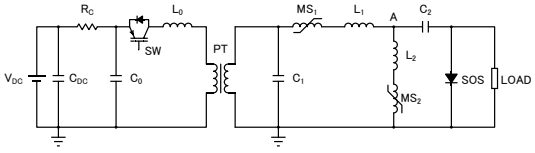
Development of processes to control the alignment of anisotropic ceramic nanosheets in strong magnetic fields and nanosecond pulsed electrical fields



■Ag Nanosheet



■Nano Pulse Power Supply



■Nano Pulse Circuit design

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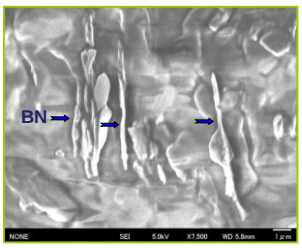
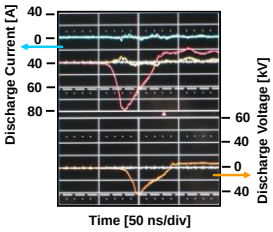
■Environmental technology and Robot technology by *Anisotropic Engineering*

Design of a novel organic-inorganic hybrid system with contrasting features (polymer vs. ceramic) to help improve the efficiency of a fuel cell

(Combined environmental technology and organic-inorganic hybrid technology)



■Anisotropic BN/Polymer Nanocomposite



■Nano Pulse Fabrication

■Application (Touch Sensor)

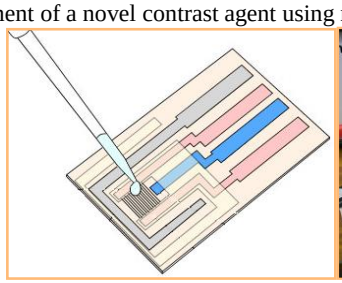
■*Micro-Nano 3D fabrication* technology & nanobiotechnology

Design of a nanoimprint mold using carbon nanotubes and biosensing

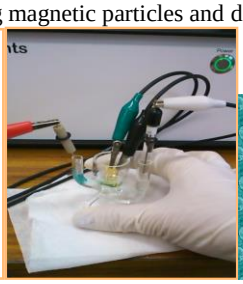
(Developed a process of forming nanostructures through use of the characteristics of CNTs)

Painless blood sampling with nanoinjection needles using polylactic acid

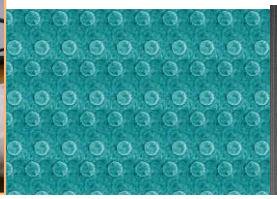
Development of a novel contrast agent using magnetic particles and development of imaging simulation software



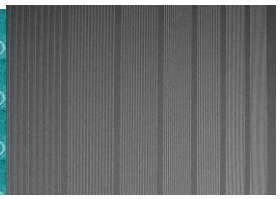
■Bio Sensor



■Bio Sensor



■Nanoimprinted Alumina



■Nanoimprinted Titania

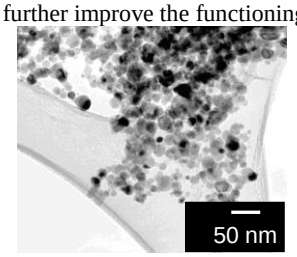
■Structural ceramics with *Nanocomposites Design Concept*

Bringing out the functions of structural ceramics through anisotropic structural control

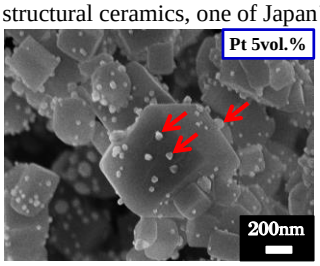
(Sought to further improve the functioning of structural ceramics, one of Japan's crowning achievements)

Creation of high-temperature structural ceramics with a high strength-to-weight ratio using nanocomposites

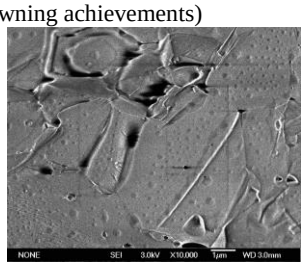
(Sought to further improve the functioning of structural ceramics, one of Japan's crowning achievements)



■Alumina Nanoparticles



■Nanocomposite Particle



■Porous Composite

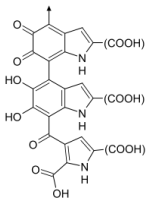
■Functional materials for *Energy Harvesting*

Equipping titanate nanotubes with new functions and elucidating their thermal and electrical properties

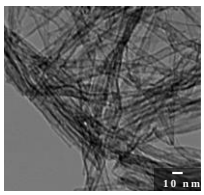
(Involved exploring the potential of titanate nanotubes, a new material developed in Japan)

Creation of a dye-sensitized solar cell with a novel nanostructure and development of environmentally-friendly processes

Construction of active electronic devices using ceramic nanotubes and verification of their operation

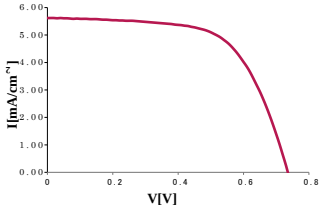


■New Dye



■Titania Nanotube

■Solar Cell



■Example of Solar Cell

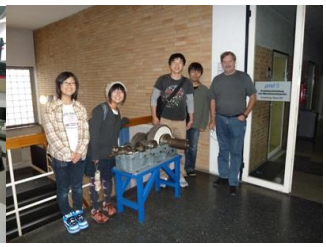
■Internationalization

The Laboratories accept researchers from around the world.
As of April 2017, exchange students and long-term foreign researchers had come from:
South Korea (2 individuals), Finland (1), China (1), Malaysia (1), Qatar (1), Mongolia (2) and Vietnam (4).

●Status of joint research with laboratories overseas
The Laboratories have conducted joint research with
UK: University of York, University of Bristol
USA: University of South Florida, Oak Ridge National Laboratory
China: Wuhan University of Technology, Xian Jiatong University
Vietnam: Hanoi University of Technology, Ho Chi Minh University of Technology
India: IIT Madras
Malaysia: Universiti Malaya
Australia: (Royal Melbourne Institute of Technology) RMIT University
Thai: Chulalongkorn University, Thammasat University, National Metal and Materials Technology Center (MTEC)
S. Korea: Sun Moon University (Priv.), Pusan National University, Inha University (Priv.), Hanyang University (Priv.), Seoul University of Technology

There are active exchanges with these universities at the student level, and these universities and Nagaoka University of Technology send out and accept exchange students. Over the last few years, large numbers of students have sought to study overseas, so every year a number of graduate students will act as research students overseas. That said, studying abroad is not compulsory and is ultimately determined by whether the student wants to study overseas. However, this environment is rich with promise for individuals who want to conduct research overseas.





■Joint research in Japan

The Laboratories are conducting joint research with universities. The Laboratories also conduct joint research with Japanese universities like Hakodate College of Technology, Tomakomai College of Technology, Nagaoka College of Technology, Tohoku University, Shinsyu University, Osaka University, Kyoto University, Tokyo Institute of Technology, Nagoya Institute of Technology, Nagoya University, and Osaka Prefecture University and hold meetings of study groups combining members from both Laboratories. Additionally, the Laboratories participate in research on a number of national projects.

■Laboratory policies and life as a researcher

The Laboratories have the fullest respect for student autonomy, so there are no set hours in which students must be present. Students are also free to work part-time to learn more about everyday life. Students are absolutely free to take weekends off at their own discretion. However, more is required of research in the Laboratories than is required of work in a regular laboratory. Over the last few years, many students have participated in academic societies at quick pace. If moving quickly, students might make a presentation at a Japanese academic society prior to the fall of their fourth year as undergraduates and make a presentation to an academic society overseas in English prior to the winter of their first year as master's students. Many graduate students also write at least one academic paper in English prior to completing their master's. Naturally, the research pace differs depending on the individual. Over the last few years in particular, many students have produced research results at such a pace.

Of course, suddenly generating such exceptional results is extremely difficult. Students should work steadily toward that goal with the guidance of individual instructors and more advanced students. The Laboratories have crafted an educational system to do just that. **When looking for work after completing a master's, students may find that their experience studying overseas or presenting research results overseas during their first year of the master's program is a big attention-getter for employers.** More importantly, that experience will

give students confidence in themselves.

The Laboratories now have 4 doctoral research associates and numerous students in the doctoral program. Such exceptional mentors thoughtfully and meticulously instruct students in how to conduct research. Such incredible experience is priceless.

■Career paths for graduating students

Most students in the Laboratories continue on into a master's program. After completion, about one-fourth will continue into a doctoral program or find employment with a private firm.

The career path following completion of a doctorate is most often an assistant professorship at a college. Ph.D. Graduates are working as instructors at schools like ***Osaka University, Tomakomai National College of Technology, Nagaoka National College of Technology*** and ***Nara National College of Technology***. Ph.D. Graduates are also working as research associates at locations like the ***Shimane Institute for Industrial Technology*** and ***the National Institute of Advanced Industrial Science and Technology***.

The career path following completion of a master's varies every year, with Master Course graduates finding work with any number of companies. These companies include ***Robert Bosch GmbH, SONY, Tohoku Electric Power Co.,Inc., Hokuriku Electric Power Co.,Inc., Panasonic, HITACHI, Sumitomo Chemical, Hitachi Chemical, Union Tool, JR East, JR Kyusyu, DENKA, Nikon, RICOH, ULVAC, JX Holdings*** and ***Kobelco***, *etc*.

■Life in the Laboratories

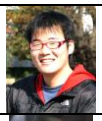
The Laboratories strive to improve the lives of their researchers since researchers are, before all else, human beings. Nagaoka is a bit rustic, so Nagaoka lacks the extravagant entertainment of the city. However, there are laboratory-wide activities like greening efforts around the laboratories (the Gardening Club), soccer and baseball game attendance (the Sports Spectator Club), softball practice (the Softball Club), and cooking and dining (the Cooking Club) and opportunities like biannual laboratory trips. Through these activities and travel opportunities, the Laboratories strive to heighten fellowship among laboratory members and create bonds that will stand the test of time. All of the students in the Laboratories are bright, and the Laboratories have an atmosphere that always facilitates an open dialogue without distinction between faculty and students. **"The Laboratory is a family."**





■Members (Prof. Nakayama's Group)

Position	Name	Research Topics	Photo
President of Nagaoka Univ of Tech (OB of our group)	Koichi Niihara	Management of Nagaoka Univ of Tech. Talking, Drinking and Cooking in our Labo. (President of the Ceramics Society of Japan)	
Professor, Principal Investigator	Tadachika NAKAYAMA	Environmental Technology, Processing, IoT, Industry 4.0, Energy Conversion, Ceramics Science, Nanocomposites, Plasma Science, Material Design Concept, Energy Harvesting, Anisotropic Engineering, Nanoimprint Process Development of Nano-process, Hybrid Materials, Nano Second and Nano Technology	
Post Doctor	Lingfeng HE	Mechanical properties of $Y_2Ti_2O_7$	
Post Doctor	Hong-Baek CHO	Anisotropic alignment of BN nanosheets in Hybrid Materials under nano pulse width electricity	
Post Doctor	Satoru ISHIHARA	Discovery of oxide ceramic material having a high pressure electric properties	
Ph.D. Candidate	Masahiro TERAUCHI	Titania nanotube based catalysts for environmental purification	
Master Course Student	Kazuyoshi IMAKI	Development of a high-throughput nanoimprint processing	
Master Course Student	Takeshi FUJIHARA	Design of 3-D Nanostrucutured Materials by Nanoimprint and Nanopulsed Electric Power Supply	
Master Course Student	Jun YOSHIMURA	Synthesis and microstructural observations of the nanosized mosaic structure of barium titanate / Pt nanocomposites	
Master Course Student	Ji Won LEE	Dye-sensitized solar cells using nanosized natural pigments and titania nanotube system	
Master Course Student	Yoshihisa OHBA	Structure control of the Co_2MnSi Epitaxial Heusler Alloy Film for spintronics devices	
Master Course Student	Satoshi AMARUME	Development of high strength ultra-light structural materials Ceramics by Nanocomposites Design Concept	
Master Course Student	Shin ENDO	Development of atomic layer deposition using nanosecond pulsed power	
Master Course Student	Satoshi ONO	Nanoimprint process of functional polymers	
Master Course Student	Masaaki TAKEDA	Development of the 3-D strucutured functional thin films by nanoimprint process	

Master Course Student	Byungjin HONG	Nanoimprint and Rapid Sintering for Functional Ceramics	
Master Course Student	Ayumi KONNO	Development of ultrasensitive biosensors and artificial antibodies nano electrode	
Master Course Student	Shin-ichi TAKAMARU	Analysis of viscoelastic behavior of the slurry containing nanoparticles	
Master Course Student	NGUYEN CHUNG TU	Remote control of Nanosized Materials by nanosecond electric pulse technology	
Master Course Student	Yuya NAKATA	Nanocomposites for Energy Harvesting	
Master Course Student	Masaya MITSUHASHI	Development of high thermal conductivity of composite sheet of epoxy resin and ceramic nanoparticles	
Master Course Student	Tsukasa YANAGITA	Transistor design and development with titania nanotubes	
Bachelor Course Student	Ryo ISHIZAWA	Development of polymeric nanocomposites for energy harvesting	
Bachelor Course Student	Akinobu NAKAMURA	MEMS design using a protein systems	
Bachelor Course Student	Huynh Tan Minh Triet	Development of simulation techniques to improve thermal management	

■Laboratory equipment

Equipment in the Laboratories is outstanding not only for Japan but is comparable to that in any laboratory worldwide. The Laboratories are fully equipped for materials development, as typified by the 2 TEMs in the Laboratories and 4 linear accelerators. Worthy of mention are devices to measure phenomena in nanoseconds that were fostered by accelerator development. Nevertheless, there is a sense of the lack of devices to assess the functional properties of some materials in comparison to the number of devices for sample synthesis and microstructural analysis. This is remedied by close coordination with groups conducting joint research domestically and abroad, providing avenues that allow access to special measuring devices. When asking that such measurements be made, students themselves approach the university or laboratory in question, allowing them to become familiar with the atmosphere of the university and the level of research being conducted there. Thus, students have the chance to study conditions at other universities without being shut up in the laboratory.

Once assigned to the Laboratories, here is some of the equipment you'll routinely have access to

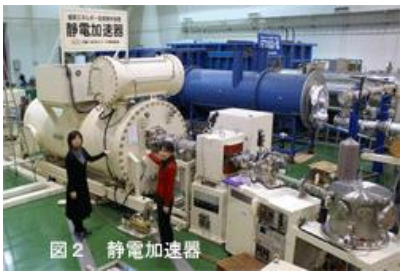


図２　静電加速器

■Equipment (for Example)

Processing

[*Ceramics*]

Hot Pressing, Furnace, Jet mill, Bead mill, High pressure presses ton 500, CIP, Horizontal grinder, Polishing, diamond wheel cutter, Homogenizer, Hybrid mixer

[*Thin Films*]

Vacuum evaporation system, Plasma CVD, Atomic layer deposition chamber, Laser ablation deposition System, DC magnetron and RF magnetron Sputtering System, Dip coating, Spin coating

[*Polymers*]

Injection molding, Kneader, Ink Wash up Blades, Organic Synthesis Columns, Hybrid Mixer

[*Others*]

Sonochemistry reactor, Hydrothermal synthesis, Microwave hydrothermal synthesis, Nano-imprint systems (×3), Molten salt synthesis method

Characterization

FE-TEM and EELS system, Dual Beam FIB, LaB_6 filament TEM (×2), Imaging plate system, FE-SEM and EDS system, XRD, AFM, FT-IR, UV-vis spectroscopy, Digital Microscope, PIPS (gatan, Ion beam milling system)

Measurements

TG-DTA-MASS system, TMA, BET surface area, Rheometer, Solar Cell Measurement System, Solid-oxide fuel cell measurement system, Wear coefficient measuring apparatus (Ball on Disc), Universal testing machine (Mechanical Properties), Micro Vickers indentation, Nano-indenter, Biosensor evaluation system, Energy Harvesting Evaluation System, SQUID magnetometer.

■Competitive Research Fund (Year 2016)　Total ; 0.82 million Dollar/year

Scientific Research Grants [Scientific Research (A)], A-STEP project (JST, Ministry of Education)
Super Hybrid Materials National Project (NEDO, Ministry of Economy, Trade and Industry)
Knowledge Cluster Project (Ministry of Education)
A3 foresight International Research Project (JSPS, Ministry of Education)
Joint research fund and/or donation from 5 companies

■Selected Recent Publications (total 206 papers)

■Strength improvement and purification of Yb2Si2O7-SiC nanocomposites by surface oxidation treatment, ***Journal of the American Ceramic Society***, Volume 100, Issue 7, 1, Pages 3122-3131 (2017).

■Superconducting water derivatives of Sr2Can-1CunO2+2n-δ (n = 2-4) high-Tc superconductors, ***Materials Chemistry and Physics***, Volume 177, 1, Pages 67-72 (2016).

■Low thermal conductivity Y2Ti2O7 as a candidate material for thermal/environmental barrier coatings, ***Ceramics International***, Volume 42, Issue 9, Pages 11314-11323 (2016).

■Insulating polymer nanocomposites with high-thermal-conduction routes via linear densely packed boron nitride nanosheets, ***Composites Science and Technology***, Volume 129, 6, Pages 205-213 (2016).

■Polymer nanocomposite films with thicknesses (≤ 30 μm) corresponding to the lateral dimension of graphite nanosheets as straightforward thermal conducting pathways, ***Composites Science and Technology***, Volume 127, Pages 106-112 (2016).

■Fabrication of stacked-cup carbon nanotube/polymer nanocomposite films with linear controlled percolation routes, ***Materials Chemistry and Physics***, Volume 171, Pages 39-44 (2016).

■Texture-controlled hybrid materials fabricated using nanosecond technology, ***Journal of the Ceramic Society of Japan***, Volume 124, Issue 3, Pages 197-202 (2016).

■Nanotwin hardening in a cubic chromium oxide thin film, ***APL Materials***, Volume 3, Issue 9, Article number 096105 (2015).

■Graphene oxide as a template for a complex functional oxide, ***CrystEngComm***, Volume 17, Issue 32, Pages 6094-6097 (2015).

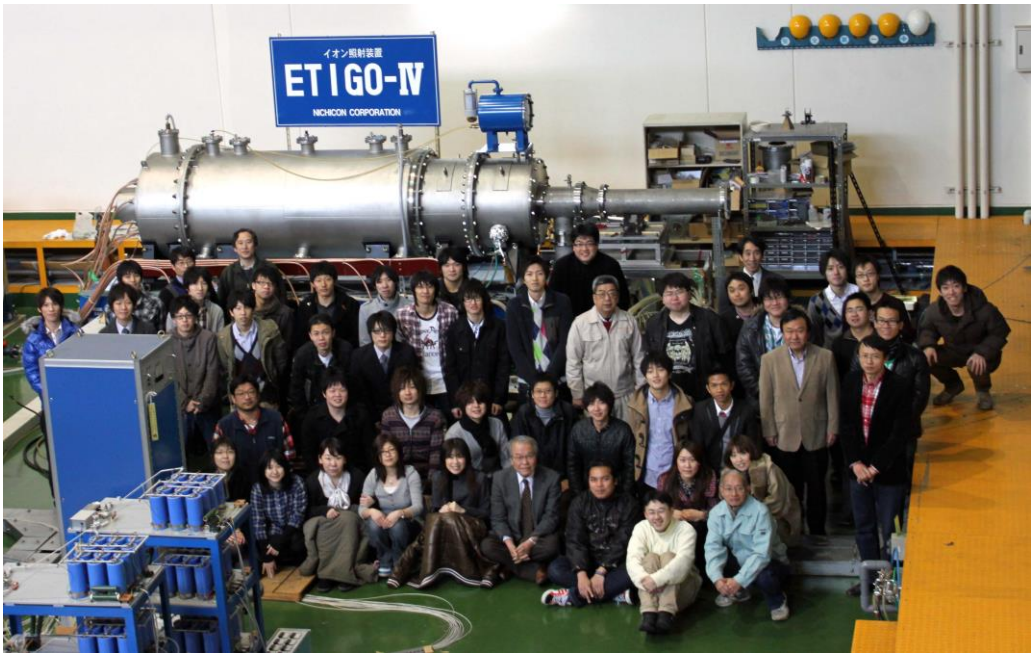
■Epitaxial growth of chromium nitride thin films with addition of silicon, ***Physica Status Solidi (C) Current Topics in Solid State Physics***, Volume 12, Issue 6, Pages 545-548 (2015).

■Synthesis of molten-metal corrosion resistant yttria-based refractory by hot-pressing and densification, ***Journal of the European Ceramic Society***, Volume 35, Issue 9, Pages 2651-2662 (2015).

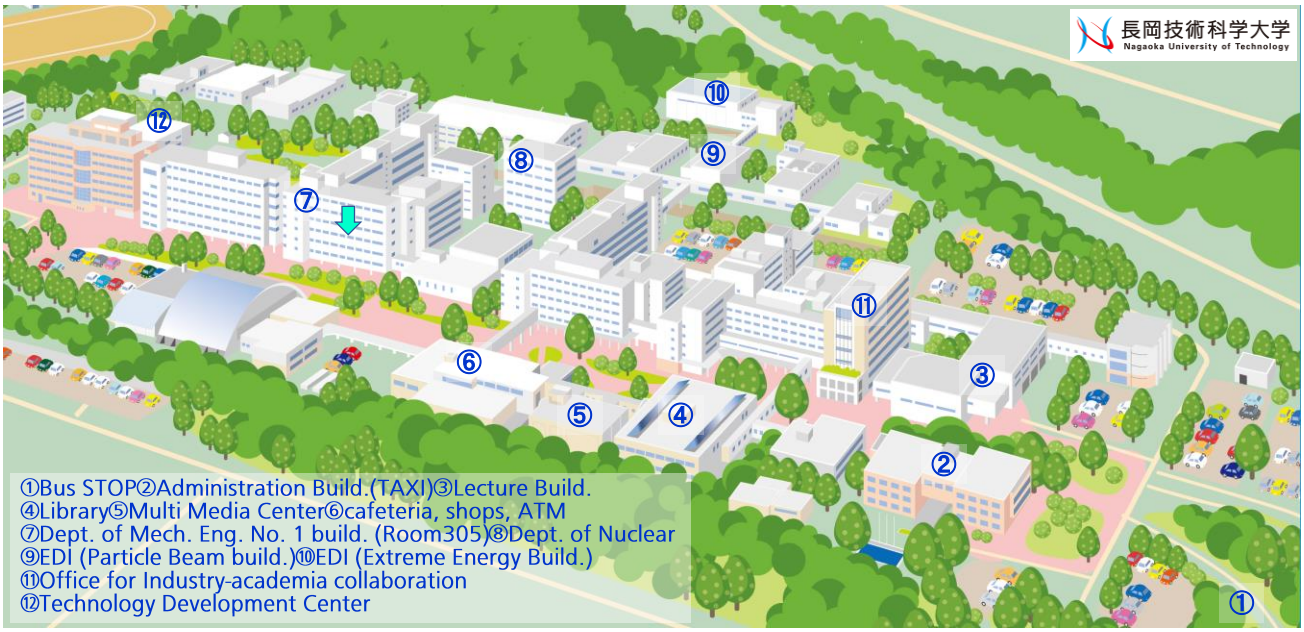
■Novel Electrothermodynamic Power Generation, ***Advanced Energy Materials***, Volume 5, Issue 13, (2015).

■Nanomechanical and optical properties of yttrium thin films by magnetron sputtering, ***Optics Letters***, Volume 39, Issue 11, Pages 3086-3089 (2014).

■Optimization of exchange bias in Co2FeAl0.5Si 0.5 Heusler alloy layers, ***Journal of Applied Physics***, Volume 115, Issue 17, Article number 17D725 (2014).



Group photo of the Extreme Energy-Density Research Institute



MAP of Nagaoka Univ of Tech

Prof. Nakayama's office: Room 305, ⑦ Dept. of Mech. Eng. No.1 Build. (see the Arrow)

ENVIRONMENT AND PROCESS DESIGN LABORATORY

長岡技術科学大学 Nagaoka University of Technology

Principal Investigator

Tadachika NAKAYAMA, Dr., Prof.

nky15@vos.nagaokaut.ac.jp
TEL ; +81-258-47-9889

Room 305, Dept. of Mech. Eng.,
1603-1 Kamitomioka, Nagaoka 940-2188 Japan

Department of Mechanical Engineering
and
Department of Science of Technology Innovation
and
Extreme Energy-Density Research Institute

Nagaoka University of Technology

Birthday	June 18th, 1971 (at Kobe, Japan)
Specialized field	Inorganic material science, Pulse power engineering, Manufacturing technology, Environmental engineering
Research object	Contribution to the community by next-generation manufacturing and environmental design
Career History	2017 Advisor to the president, **Nagaoka University of Technology** (Strategic Project Manager) 2017 Senior URA, **Nagaoka University of Technology** (University Research Administrator) 2017 Professor, **Nagaoka University of Technology** 2010 JSPS Fellow @**University of York** (UK) 2008 Associate Professor, **Nagaoka University of Technology** 2005 Assistant Professor, **Nagaoka University of Technology** 2000 Assistant Professor, **Osaka University**
Educational Background	2000 Ph.D., **Osaka University**, Graduate School of Engineering Graduate, Department of Applied Chemistry (Supervisor; Prof. Koichi Niihara) 1997 Master of Eng., **Osaka Prefecture University**, Graduate School of Engineering, Department of Material Science (Supervisor; Prof. Toshiyuki Matsui, Prof. Kenji Morii) 1995 Bachelor of Eng., **Osaka Prefecture University**, Graduate School of Engineering, Department of Material Science (Supervisor ; Prof. Toshiyuki Matsui, Prof. Yutaka Nakayama)
One Word	We aim to create human resources and technologies that can be active in 2050. I think that the essence of things is grasped and the problem solving method based on that will lead to the creation of innovation. With this kind of approach, we train people capable of proposing potential needs, and we are working on region creation by setting up an environment where they can play an active role in each region of the world. **This laboratory welcomes admission from the graduate school. Students who wish to challenge new research from graduate schools who are graduate from college of technology colleges or other universities would be pleased if they could contact me by e-mail.**

Affiliation Societies	The Ceramics Society of Japan, Applied Physics Society, Powder Engineering Society, The American Ceramics Society, The Japan Metallurgical Society, The Automobile Manufacturers Association
Selected Awards	2004 Powder Powder Metallurgy Association, Research Advance Award 2007 The Ceramic Society of Japan, Progress Award 2013 The finalists for the 2013 *Journal of Materials Science*, Robert W. Cahn Best Paper Prize 2016 Global Star Award, Engineering Ceramics Division, American Ceramics Society 2016 The Commendation for Science and Technology by the Minister of Education, Culture, Sports, Science and Technology (MEXT) 2016 Richard M. Fulrath Award, American Ceramics Society

Access to our laboratory

From Tokyo

Train TOKI (JR Joetsu Shinkansen-Line) go to JR Nagaoka Station (1 hour 45 minutes from Tokyo)

From JR Nagaoka Station, Echigo KOTSU Bus from Otemae Exit Bus Station (Stop No.7) (30 min - 320 Yen)

Our University is final stop (the name of bus stop is GIDAI-MAE)

by TAXI ; It takes about 20 minutes, about 2,700 yen from Nagaoka station.

From Fukuoka, Sapporo, Osaka, Seoul, Shanghai etc.

From Niigata airport by limousine bus to JR Niigata station (25 minutes - 410 yen)

From JR Niigata station to JR Nagaoka station by Train TOKI (Joetsu Shinkansen) (22 minutes)

※ JR Niigata ⇄ Nagaoka Station, we have special discount ticket [Shinkansen Double tickets (round trip 4,200 yen)].