Nano-communication Design in Graduate-level Education and Research Training Programs

Institute for NanoScience Design,
Osaka University,
Japan
Outline

• Characteristics of Nanoscience and Nanotechnology and Their Education System
• Osaka University Nano-programs
• Distance Live Education System
• Liaison between University and Industries
• Nano-communication Design Programs
Characteristics of Nanoscience and Nanotechnology:
- open field beyond the conventional scientific disciplines
- necessity of multi-/inter-/trans-disciplinary education
- necessity of rapid adaptation to newly emergent fields
- key technology for future science and technology
- difficulty in characterization and analysis (homogeneity, toxicity, etc.)

Essential Elements for Nano Education and Training:
- firm background for one’s own field
- basic skill for design, fabricate, measure, analysis, etc.
- interest and knowledge of emerging nano-related fields
- ability for applying one’s own nano skill to other fields
- knowledge for public engagement and risk management

→ Trans-faculty minor program is most adaptable!

Independent graduate-level education programs:
Balance between the warp and the weft
Liaison among academia, industry and government
OU-NANOPROGRAM
(Osaka University Advanced Inter-/ Multi-Disciplinary Graduate-level Programs for Education, Research and Training in Nanoscience-/Nanotechnology)

Purpose: Challenge to educate university students of natural science and engineering and also full-time researchers and engineers in Industries for getting the necessary knowledge, understanding, skills to interact and provide leadership in nano-fields.

Five Basic Fields of Interest

• Computational NanoMaterials & NanoDevice Design
  Quantum simulation, First principle calculation
• NanoElectronics & NanoProcessing
  Quantum effects, Nanodevice, Nanoprocessing
• Supra-Molecules & NanoBioprocesses
  Synthesis of Giant Molecule, BioNanofunction
• Nanostructure Characterization & Analysis
  Structural analyses by electron-beam, x-ray and AFM/STM
• NanoPhotonics
  Super-high resolution, Nano-opto device, Quantum information
Five Pillars of OU-NANOPROGRAM 2010

**Education & Research**

1. Master COURSE from SY2004
2. Doctor COURSE (AMER) from SY2004
3. Doctor COURSE (AIL-PAL) from SY2005
4. Refresher COURSE from SY2004
5. **Public Engagement and Roadmap Design** (Lecture and Practice) from SY2010

**Social Contribution**

Supporting Organization with members of about 30 companies: ALICE-ONE (Academia-Industry Liaison Consortium for Education of NanoScience and NanoEngineering)
OU-NANOPROGRAM OUTLINE

**MASTERAL COURSE**

- **Advanced Interdisciplinary Education Program**
  → One year lectures (90) plus hands-on laboratory training (25)
  To grow the development ability not only in their own field but also in the surrounding different fields

**DOCTORAL (PhD) COURSE**

- **Academia–Industry Liaison Project–Aimed Learning and Training (AIL–PAL)**
  → One year educational training in cooperation with industries (4)
  To get the knowledge and experience concerning industrial R&D method

- **Advanced Multi–Disciplinary Exploratory Research (AMER)**
  → One year research training for students belonging to different fields (5)
  To achieve harmonious planning, discussion, research and writing paper

**REFRESHER**

- **Graduate–level refresher program (Part–time students)**
  → One year lectures and hands-on laboratory training and debates (4)
  To make young professionals with leadership in nano-related industries

Special lecture series for NT career up
MASTERAL COURSE (OU-NANOPROGRAM) (One year including Hands-on Laboratory Training)

Masteral Course Curriculum

About 90 subjects pooled from existing ones offered in the 6 graduate programs at OU and some specially prepared.

~90 subjects

Advanced Interdisciplinary Education Program

Inside one’s Curriculum

Outside one’s curriculum

Five Courses
- Computational NanoMaterials & NanoDevice Design
- NanoElectronics & NanoProcessing
- Supra-Molecules & NanoBioprocesses
- Nanostructure Characterization & Analysis
- NanoPhotonics

Started from SY2004-2005

8 units of course work + short-term hands-on (at least 1 unit)

Certificate of Completion Awarded by University President from SY2008

HANDS-ON LAB. TRAINING, NT-Career Up Lectures

About 90 subjects pooled from existing ones offered in the 6 graduate programs at OU and some specially prepared.

Inside one’s Curriculum
NANOLAB Hands-on Practices for Five Courses Common for Graduate and Refresher Program

- Laser Ablation and Quantum Structure Fabrication
- Confocal Microscopy and Bioimaging
- Transmission Electron Microscopy
- Electron Beam Lithography and AFM Observation
- Laser Trapping and Optical Characterization
- Computational Material Design Tutorial and Practise
DOCTORAL PROGRAM (1 day/week for one year)
Advanced Multi-Disciplinary Exploratory Research (AMER)
3~4 students from different fields forms one group to share their sub-subjects depending on their own specialty. *Very motivative for multidisciplinary thinking*

- Nano-Materials and Device Design with Using Computational Design Techniques
- Measurement and Characterization of Nanomaterials and Their Functionality by Means of Transmission Electron Microscope
- Fabrication and Characterization (Physical and Optical) of Periodically-poled Dielectric Nanomaterials
- Fabrication of Nanostructures with Using Electron Beam Lithography
- Bio-imaging by Means of Confocal Two-Photon Microscope and Raman Microscope
DOCTORAL PROGRAM (1 day/week for one year)  
Academia-Industry Liaison Project-Aimed Learning & Training  
Two coordinators are nominated on both sides. Part-time professor from industry conducts brainstorming, project planning, practice, internship, presentation, and publication (or patent preparation) for a small group of 3~4 PhD students. *Hard but very motivative for social practice and job-hunting*

- Exploring the Properties of NanoFoams Fabricated in Supercritical Fluid offered by Panasonic Co., Ltd.
- MEMS (Micro-Electro-Mechanical Systems) Technology for Medical Sensors and Bio-Actuator Applications offered by Toshiba Corp.
- Two more research topics are Electroluminescent Organic Thin Films offered by Panasonic Electronic Co., Ltd. and Organic Pigments containing Nanoparticles offered by BASF (Badische Anilin- & Soda-Fabrik) Japan Ltd.

Students experience industrial ways of thinking and public implication.
Graduate-level RERESHER PROGRAM (One Year)

Researchers, Engineers In Nano Industries

Part-time Graduate Students

Once a Week

Weekday Evening Class

Distant Education

3 hours x 30 weeks x 4 courses

Tailor-made Program

HANDS-ON Lab. Training (Schooling)

Four Courses from Monday to Thursday
- Computational NanoMaterials & Device Design
- NanoElectronics & NanoMaterials
- Supra-Molecules & NanoBio Photonics
- Nanostructure Characterization & Analysis

Creating Highly talented professionals, Matching between seeds and needs

Certificate of Completion (with 9 credits)
### Course 3: Supramolecules and Nano-bioprocesses (First Semester SY2007-8)

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<th>code</th>
<th>theme</th>
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<td>14</td>
<td>7/9 Debate on perspective</td>
<td>3A-14-A</td>
<td>3A-14-B</td>
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Four courses are newly prepared with contribution of ~100 lecturers. Each course consists of 30 lectures (13x2 semesters ordinary lectures, 2 common lectures for all courses, and 2 classes for debate) + Hands-on laboratory training (30 hours)
DISTANCE LEARNING/EDUCATION NETWORK
(16 local satellite class rooms in Japan up to 2010)

INTERNET STREAMING
(for e-learning)

RECORDERING

LIVE/INTERACTIVE

OSAKA UNIV.
NAKANOSHIMA CENTER
EVENING SCHOOL
18:00~21:00

KYOTO Keihanna,
SHIGA, NARA,
KOBE

TOKYO Branch
Campus Innovation Center (CIC)
Osaka University Office,
KANAGAWA

SUITA Branch
Osaka University Nanotech Center

TOYONAKA Branch
NANOPROGRAM office
with Nano Laboratory

YOKKAICHI
Chamber of Commerce and Industry,
HITACHI-NAKA, CHIBA,
TSUKUBA, AICHI

In cooperation with industries
## Summary of Numbers of Completed Students (Registered Students) in Nano Courses

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<th>2004</th>
<th>2005</th>
<th>2006</th>
<th>2007</th>
<th>2008</th>
<th>2009</th>
<th>2010</th>
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<td><strong>Master Students</strong></td>
<td>(134)</td>
<td>(140)</td>
<td>(107)</td>
<td>(100)</td>
<td>(94)</td>
<td>(78)</td>
<td>(58)</td>
<td>(711)</td>
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<td>5</td>
<td>5</td>
<td>5</td>
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<td>90</td>
<td>91</td>
<td>91</td>
<td>93</td>
<td>110</td>
<td>112</td>
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<tr>
<td><strong>Doctor Students</strong></td>
<td>(1)</td>
<td>(11)</td>
<td>(13)</td>
<td>(16)</td>
<td>(11)</td>
<td>(9)</td>
<td>(12)</td>
<td>(73)</td>
</tr>
<tr>
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<td>5</td>
<td>5</td>
<td>7</td>
<td>8</td>
<td>5</td>
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<td>2</td>
<td>1</td>
<td>3</td>
<td>3</td>
<td>2</td>
<td>2</td>
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<tr>
<td>AMER</td>
<td>1</td>
<td>3</td>
<td>4</td>
<td>4</td>
<td>5</td>
<td>3</td>
<td>3</td>
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<tr>
<td><strong>Refresher Students</strong></td>
<td>(43)</td>
<td>(96)</td>
<td>(121)</td>
<td>(106)</td>
<td>(134)</td>
<td>(50)</td>
<td>(74)</td>
<td>(624)</td>
</tr>
<tr>
<td>No. Courses</td>
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<td>5</td>
<td>5</td>
<td>5</td>
<td>5</td>
<td>4</td>
<td>4</td>
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AIL-PAL: Academia-Industry-Liaison Project Aimed Learning & Training
AMER: Advanced Multidisciplinary Exploratory Research
Liaison between University and Industry for Nanoscience and Engineering Education

University
- Seed, mono-discipline, and basic science oriented
- Shortage of practical sense for current applied technology

Industry
- Needs, multidiscipline, and applied engineering oriented
- Shortage of refresher training for state-of-the-art basic science

Necessity of mutual collaboration including public engagement, risk assessment, ethics, etc

Assessment of Skill Standard for Advanced Graduate-level Nano-Programs of Practical Use
University-Industry-Government Cooperation

Alliance for Research and Education on NanoScience and NanoTechnology

6 Graduate Schools, 6 Research Institutes and Centers related to NanoScience and NanoTechnology

Trans-disciplinary program

Center for Interdisciplinary Research and Education

Refresher program

Institute for NanoScience Design

Coordinator, research assistants
Planning, hands-on practise, broadcasting

government
funding
budget
insentive

university headquarter

Administrative office

consortium
ingovernment funding support
industry

Academia-industry liaison education

Graduate school advanced education
Academia-Industry Liaison Consortium

Osaka University

Education
- Master Course
- Nanotechnology Career-up Special Lecture
- Refresher Course

Institute for NanoScience Design
- PhD Course
- Academia-Industry Liaison Training
- Trans-disciplinary Research Training

Research

Industry Liaison Program
- Part time student
- Industry Coordinator
- Basic education for young people

Liaison Consortium
- General Meeting
- Committee
- Finance
- Working Group
  - Education Curricula WG
  - Research/Develop. WG
  - Investigation Working

Industries

individual

PhD degree support

Industries promoting Nanotech.
Nanotech. Business Creation Initiative

Financial support

Information, technology exchange

Nanotechnology collaboration work

Application of OU Knowledge
Nano-Communication Programs Including Ethical, Legal, Social Relationship  
~Society and Safety~

• Nanotechnology Career-up Lectures

• Special Lecture of Public Engagement on Nanotechnology

• Special Lecture of Road Map Design on Nanotechnology

• Project-Aimed Learning and Training Programs (PAL)
Nanotechnology Career-up Lectures
(from spring semester 2007)

• Series of omnibus lectures of 30 hours
• Taught by 15 researchers and engineers working in nano-related industries and institutions
• Introducing various kinds of their knowledge and experiences on application of nano-technology, such as cost performance, societal implication, etc.
• Importance of public engagement, entrepreneurship, intellectual property, business model, etc.
Special Lecture of Social Engagement on Nanotechnology  (from spring semester 2010)

- Intensive course of 15 hours including exercise
- Organized by Dr. Masafumi Ata, AIST
- Taught by researchers and government officials working at nano-related institutions, universities and government offices
- Specialized in public engagement, risk assessment and administrative management, standardization, etc.
Special Lecture of Road Map Design on Nanotechnology (from autumn semester 2010)

- Intensive course of 30 hours including exercise
- Taught by engineers belonging to nano-related industries engaged in planning road maps for future products at NBCI (Nanotechnology Business Creation Initiative)
- Introduces several important future industrial products together with their road maps
- Dealing with necessary appliance and public engagement of many kinds of basic elemental engineering in relationship with the specialty of graduate-level students and engineers
Road Maps for Selected Subjects

- Nano-sensing
- Display and imaging (flat, flexible, large-small)
- New nano-devices
- Nano-bio simulation
- Fuel Cell (proton exchange nano-porous membrane)
- Ultra-accurate nano-processing
- Nano-particles (catalyst, semiconductor)
- Nano-measurement
International Academic Exchange in the fields of Nanoscience and Nanotechnology

**European Activities in Nanoscience Education**

**Nanotech Degree Course in Europe**
*Nanoforum* (Education Catalogue for Higher Education in Nanotechnology)

The University of Groningen;
Top Master Program in Nanoscience/
MSC PhD Program at Zernike Institute for Materials Science

Ludwig-Maximilian University, Munich;
PhD program at Center for Nanoscience

University of Prais 6,
Graduate programs at the Institute of Nanosciences in Paris
International Academic Exchange in the fields of Nanoscience and Nanotechnology

Asian Activities in Nanoscience Education

Nanotech Research Training Course in South-East Asia
Joint Master Program: Graduate School of Engineering Science and Vietnamese Academy of Science and Technology

Nanotech Research Training Course in South-East Asia
Video lecture (Osaka-Vietnam-Europe)

Research Training (Experimental Course at Osaka)
Vietnam, Malaysia, Thailand, etc.

Research Training (CMD at each country)
Vietnam, Philippine, Indonesia, etc.
Acknowledgement:
FY2004-2008 Japan MEXT Special Coordination Fund for Promoting Science and Technology, “Fostering Talent in Emergent Research Fields”
FY2009-2013 Japan MEXT Special Budget for Educational Reform

OU-NANOPROGRAM
http://www.sigma.es.osaka-u.ac.jp/pub/nano/

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