



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

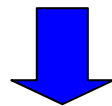
Characteristics of Nanoscience and Nanotechnology

- 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

Social Contribution

Academia

Industry

1. Master COURSE

from SY2004

from SY2006

CAREER-UP LECTURES for social, legal, ethical relationship

2. Doctor COURSE (AMER)

from SY2004

from SY2005

3. Doctor COURSE (AIL-PAL)

from SY2004

4. Refresher COURSE

from SY2010

5. Public Engagement and Roadmap Design (Lecture and Practice)

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

Special lecture series for NT career up

· **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

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.

Five Courses

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

~90 subjects

Started from SY2004-2005

Advanced Interdisciplinary Education Program

Inside one's Curriculum

Outside one's curriculum

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

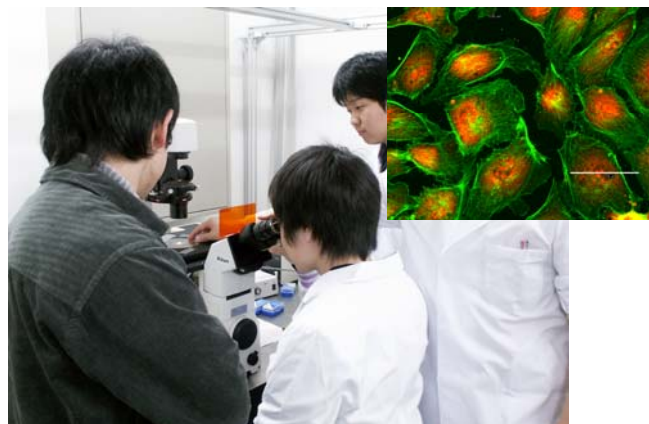
HANDS-ON LAB. TRAINING,
NT-Career Up Lectures

Certificate of Completion
Awarded
by University President
from SY2008

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**



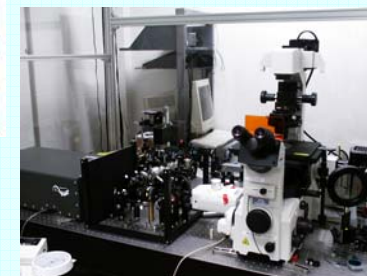
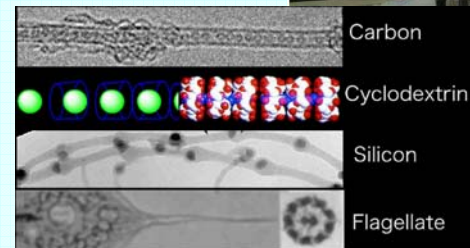
**Computational
Material Design
Tutorial and Practise**

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 motivating 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

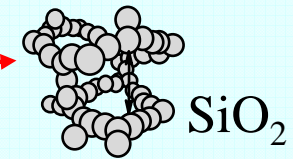
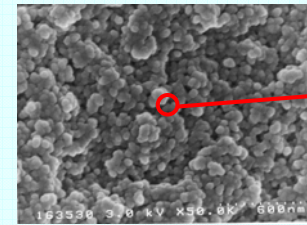
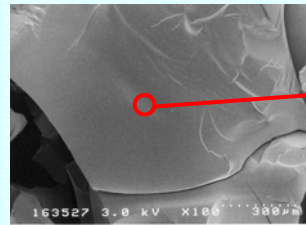


DOCTORAL PROGRAM (1 day/week for one year)

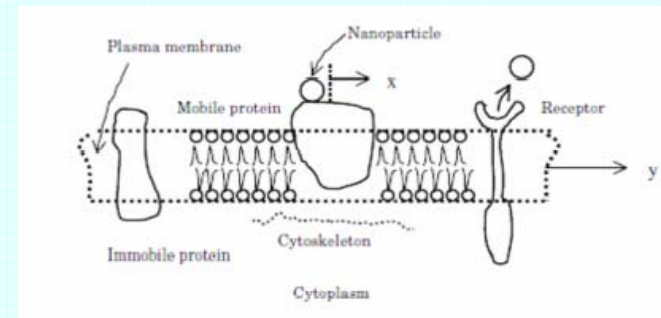
Academia-Industry Liaison Project-Aimed Learning & Training

Two coordinators are nominated on both sides. Part-time professor from industry conducts brain storming, 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.**



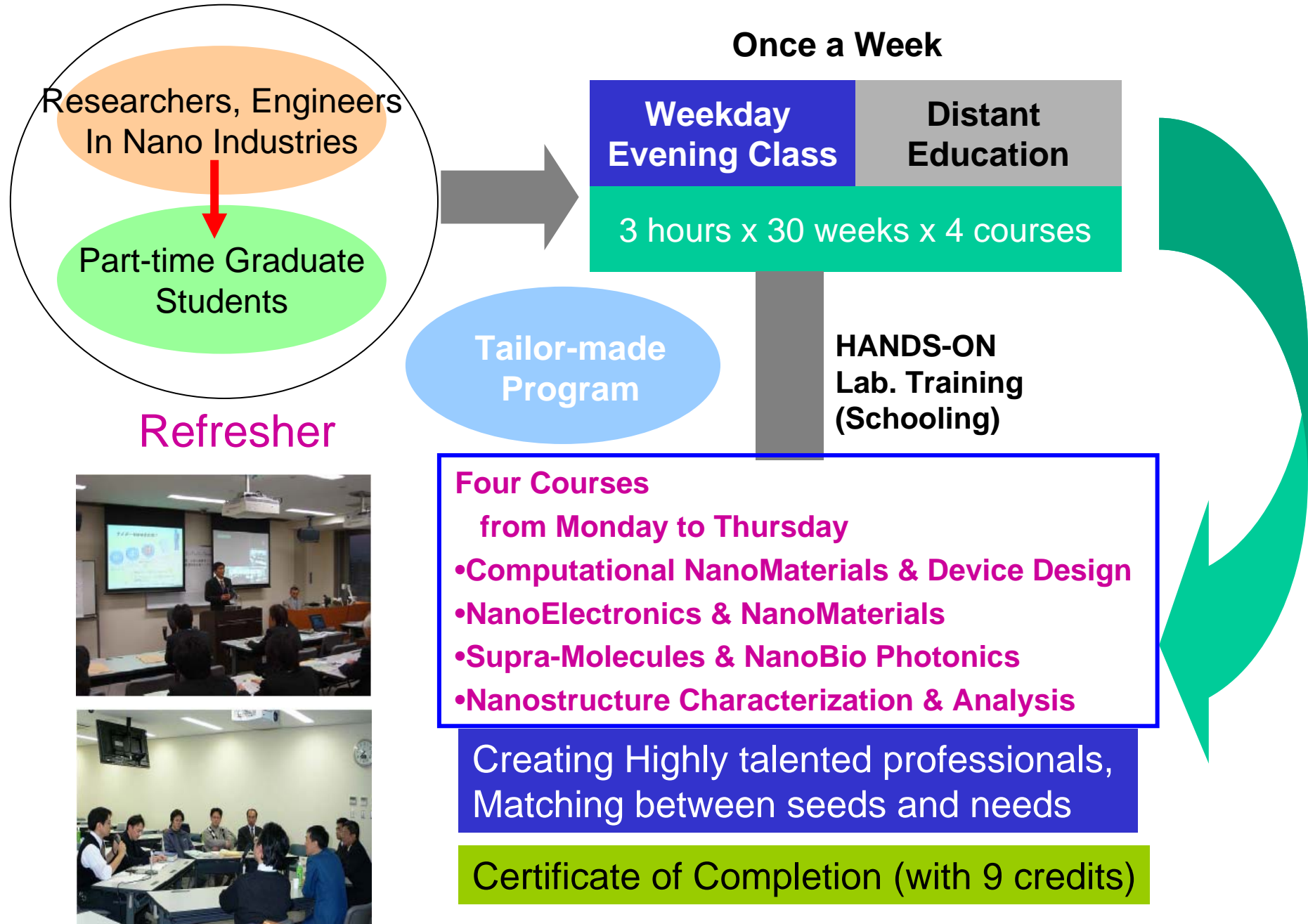
- **MEMS(Micro-Electro-Mechanical Systems) Technology for Medical Sensors and Bio-Actuator Applications** offered by **Toshiba Corp.**



- 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)



Course 3: Supramolecules and Nano-bioprocesses (First Semester SY2007-8)

	date	subject	code	theme	lecturer
1	4/9	Introduction, bio-structure	3A-1-A	<div style="border: 2px solid red; background-color: yellow; padding: 10px; text-align: center;"> <p>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)</p> </div>	
			3A-1A		
2	4/16	Bio-photonics-I	3A-2-A		
			3A-2-B		
3	4/23	Bio-nanomachine	3A-3-A		
			3A-3-B		
4	4/25	Optical Microscopy	3A-4-A		
			3A-4-B		
5	5/7	Bio-photonics-II	3A-5-A		
			3A-5-B		
6	5/14	Nano Bio-mechanics	3A-6-A		
			3A-6-B		
7	5/21	Molecular Spectroscopy	3A-7-A		
			3A-7-B		
8	5/28	Supramolecule Calculation	3A-8-A		
			3A-8-B		
9	6/4	Nanomolecular material	3A-9-A		
			3A-9-B		
10	6/11	Suprapolymer-I	3A-10-A		
			3A-10-B		
11	6/18	Suprapolymer-II	3A-11-A		
			3A-11A		
12	6/25	Beam chemistry	3A-12-A		
			3A-12-B		
13	7/2	Interface chemistry	3A-13-A		
			3A-13-B		
14	7/9	Debate on perspective	3A-14-A		
			3A-14-B		



DISTANCE LEARNING/EDUCATION NETWORK (16 local satellite class rooms in Japan up to 2010)

*INTERNET STREAMING
(for e-learning)*



RECORDING



LIVE/INTERACTIVE

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



**TOYONAKA Branch
NANOPROGRAM office
with Nano Laboratory**

**KYOTO Keihanna,
SHIGA, NARA,
KOBE**

**SUITA Branch
Osaka University
Nanotech Center**

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

**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

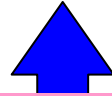
	2004	2005	2006	2007	2008	2009	2010	Subtotal Total
Master Students	(134) 39	(140) 67	(107) 51	(100) 53	(94) 62	(78) 55	(58)	(711) 327
No. Courses	4	5	5	5	5	5	5	
No. Subjects	70	90	91	91	93	110	112	
Doctor Students	(1) 1	(11) 10	(13) 12	(16) 12	(11) 9	(9) 6	(12)	(73) 50
No. Courses	1	5	5	7	8	5	5	
AIL-PAL	0	2	1	3	3	2	2	
AMER	1	3	4	4	5	3	3	
Refresher Students	(43) 22	(96) 73	(121) 94	(106) 86	(134) 113	(50) 49	(74)	(624) 437
No. Courses	4	5	5	5	5	4	4	(1408) 814

AIL-PAL: Academia-Industry-Liaison Project Aimed Learning & Training
AMER: Advanced Multidisciplinary Exploratory Research

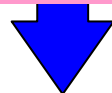
Liaison between University and Industry for Nanoscience and Engineering Education

University

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



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

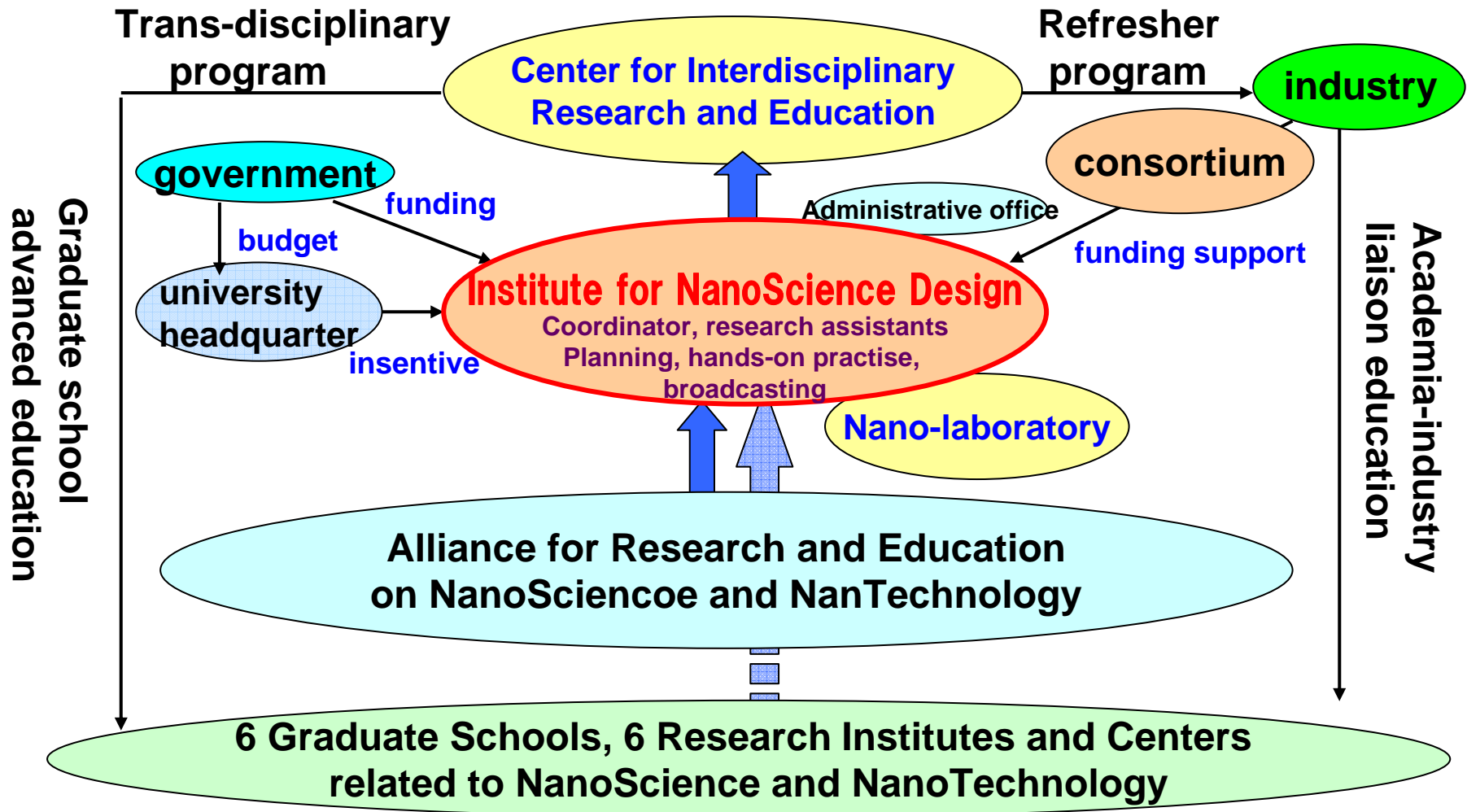


Industry

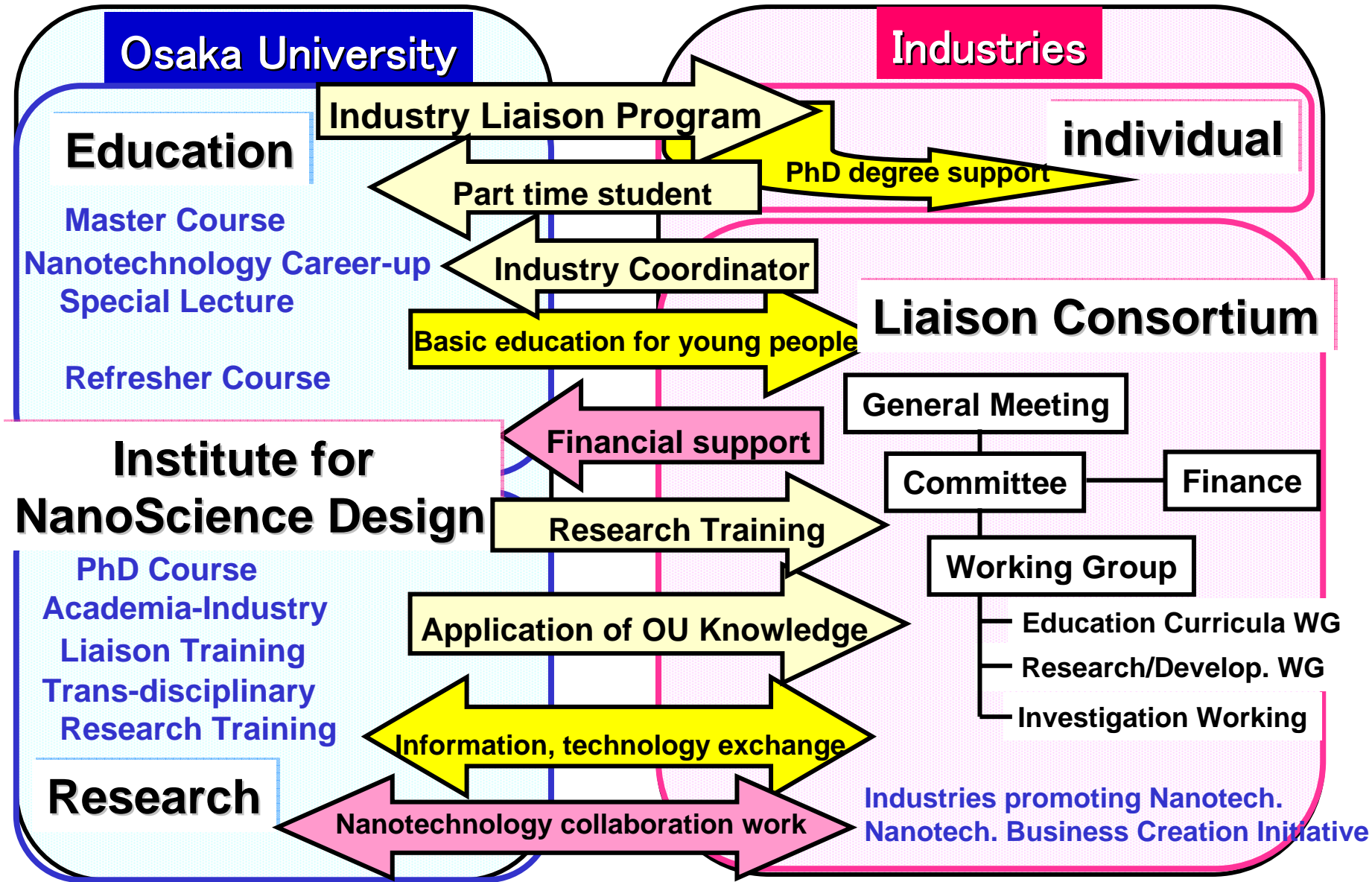
- Needs, multidiscipline, and applied engineering oriented
- Shortage of refresher training for state-of-the-art basic science

Assessment of Skill Standard for Advanced Graduate-level Nano-Programs of Practical Use

University-Industry-Government Cooperation



Academia-Industry Liaison Consortium



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 in EU, The 6th Framework Program (2002-2006)

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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