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

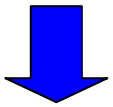
Characteristics of Nanoscience and Nanotechnology

- 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

- Refresher Program

  1) Computational NanoMaterials & NanoDevice Design

  Quantum simulation, First principle calculation, Materials informatics

  2) NanoElectronics-Materials & NanoDevices

  Quantum effects, Nanodevice, Nanoprocessing

  3) Nano Life Science (*Supra-Molecules and NanoBioprocesses)

  Bio-Nanofunction, Nanomedicine, Drug

  4) NanoStructure Characterization & Analysis

  Structural analyses by electron-beam, x-ray and AFM/STM

  5) Nano Functional Chemistry (*NanoPhotonics)

  Li-ion battery, Nanocatalysis, Quantum chemistry

- Graduate Program (courses 3 and 5 are replaced with *)

Five Pillars of OU-NANOPROGRAM

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 80 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 plus hands-on laboratory training

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

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 harmonous planning, discussion, research and writing paper

REFRESHER

・Graduate-level refresher program (Part-time students)

→ One year lectures and hands-on laboratory training and debates

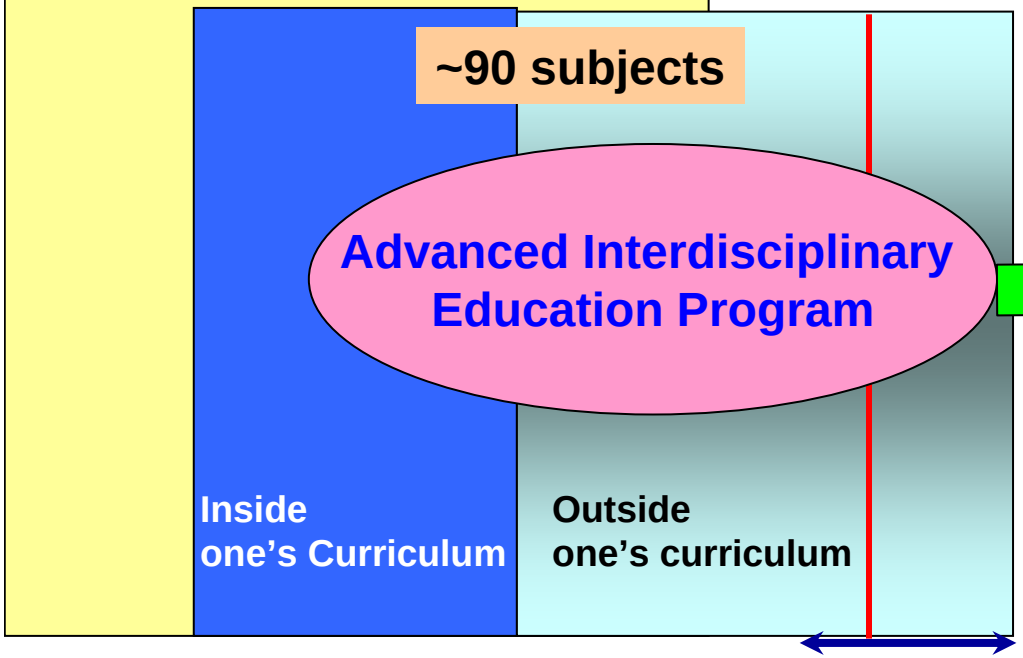
To make young professionals with leadership in nano-related industries

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**



Started from SY2004-2005

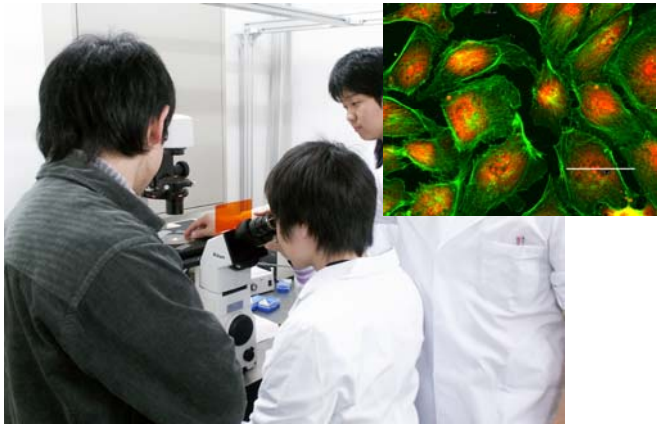
8 units of course work
+
short-term hands-on
(at least 1 unit)

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

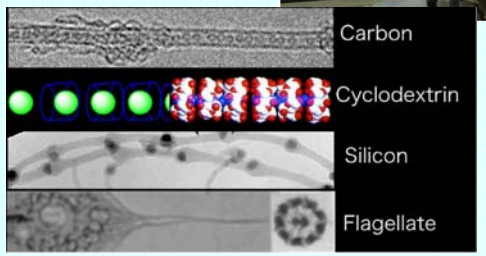
DOCTORAL PROGRAM (1 day/week for one year)

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 motivative for multidisciplinary thinking*

- **Nano-Materials and Device Design with Using Computational Design Techniques**

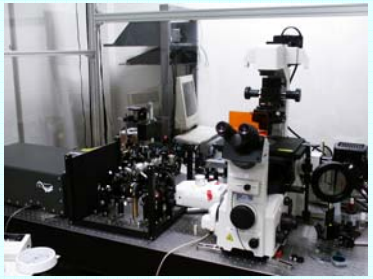
- **Measurement and Characterization of Nanomaterials and Their Functionality by Means of Transmission Electron Microscope**



- **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**

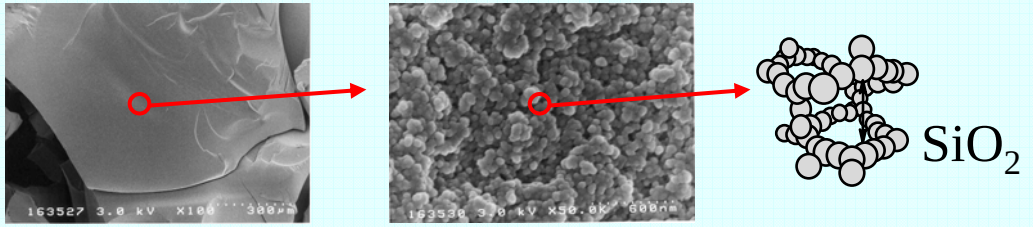


DOCTORAL PROGRAM (1 day/week for one year)

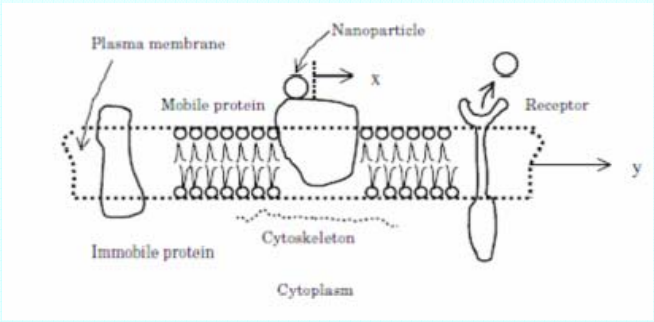
Academia-Industry Liaison Project-Aimed Learning & Training

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

Refresher

Once a Week

Weekday Evening Class	**Distant Education**

3 hours x 30 weeks x 4 courses

Tailor-made Program

HANDS-ON Lab. Training (Schooling)

Five Courses **from Monday to Friday**

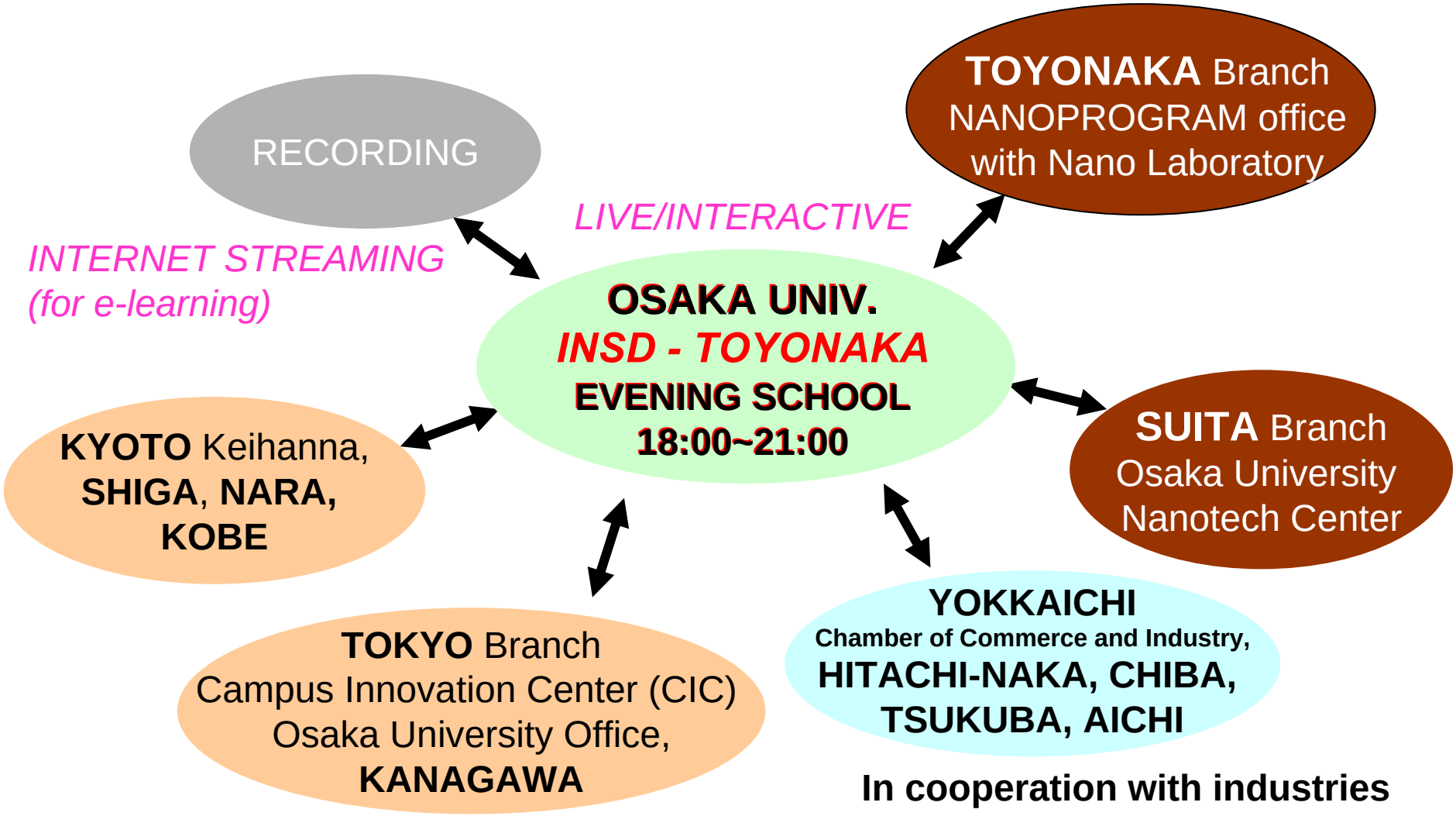
- **Computational NanoMaterials & Device Design**
- **NanoElectronics-Materials & NanoDevices**
- **Nano Life Science**
- **Nanostructure Characterization & Analysis**
- **Nano Functional Chemistry**

Creating Highly talented professionals,
Matching between seeds and needs

Certificate of Completion (with 9 credits)

DISTANCE LEARNING/EDUCATION NETWORK

(3 local satellite class rooms and on-line for individuals)



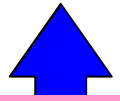
In cooperation with industries

Liaison between University and Industry for Nanoscience and Engineering Education

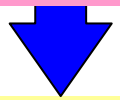
University

-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



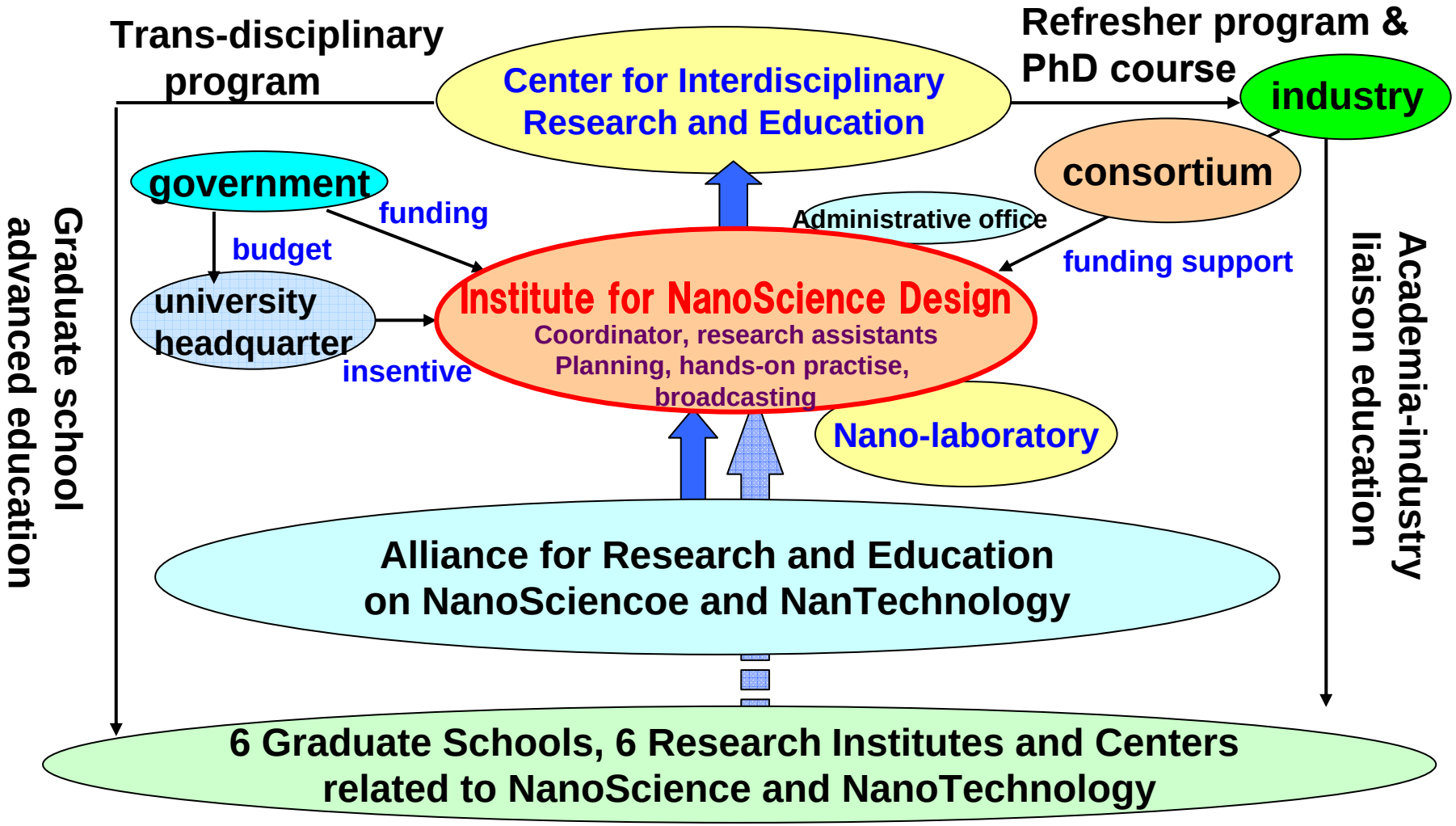
Industry

-Needs, multidiscipline, and applied engineering oriented

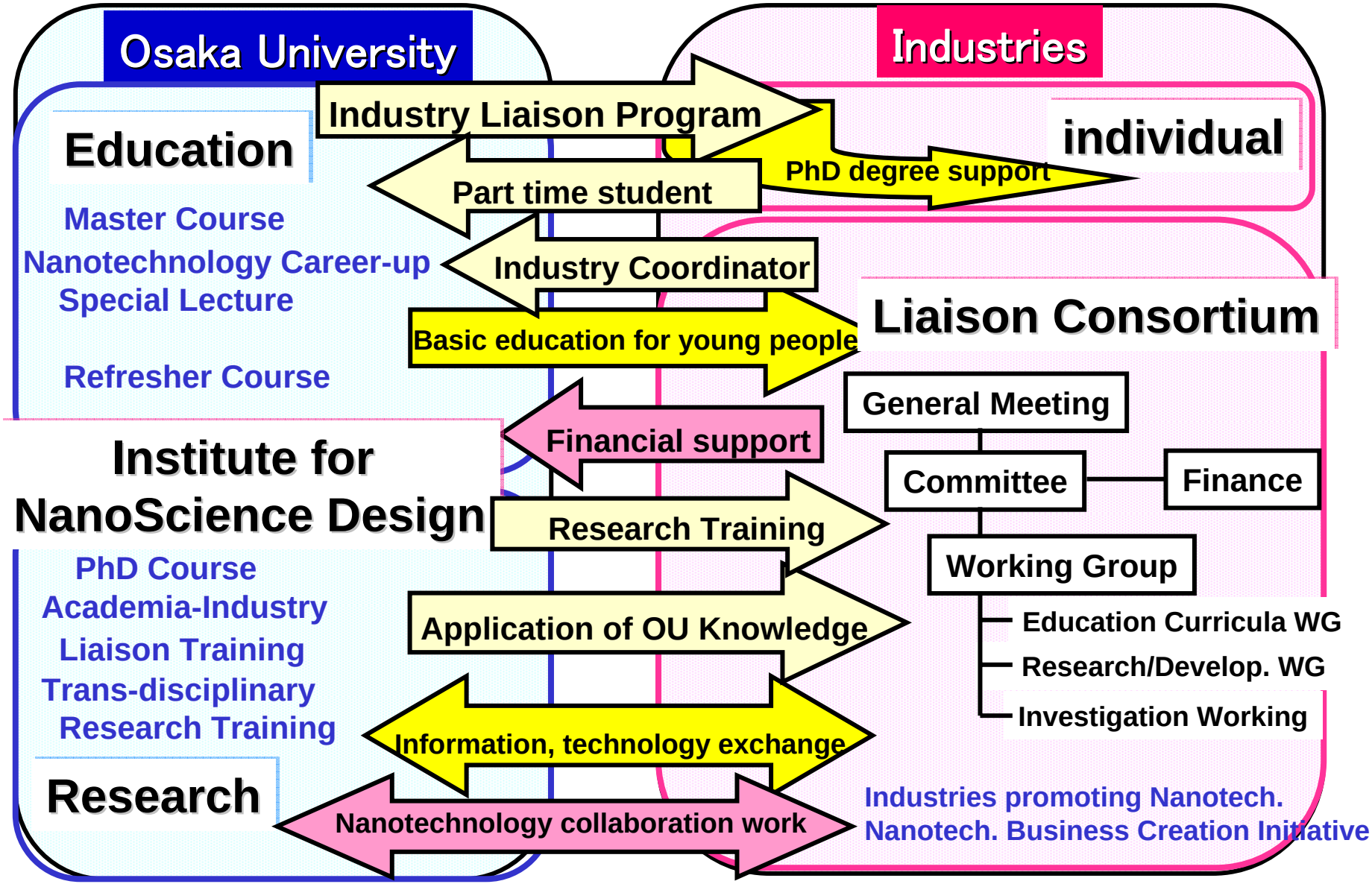
-Shortage of refresher training for state-of-the-art basic science

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 30 hours including exercise
- Organized by Dr. Masafumi Ata, Zeon Corporation
- Taught by researchers and government officials working at nano-related institutions, universities and government offices
- Specialized in public engagement, risk assessment and administrative management, intellectual property and open innovation, 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

International Exchange Lectures

Collaboration with Nanoscience Top Master Course of the University of Groningen, the Netherlands

INSD Summer School on Nanoscience and Nanotechnology

The University of Groningen;
Nanoscience Top Master Program/MSc and 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

ASEAN Activities in Nanoscience Education

ASEAN Campus OUICP-nano (Osaka University International Certificate Program for Short-term foreign student)

- Nanoscience and Nanotechnology as Manufacturing Core

Video lecture (Osaka-ASEAN-Europe)
Research Training (Experimental Course at Osaka)

Vietnam, Malaysia, Thailand, Indonesia, etc.

Distance Research Training (Computational Materials Design)

Vietnam, Philippine, Indonesia, etc.

OU-NANOPROGRAM

http://www.insd.osaka-u.ac.jp/nano/Homepage(Eng)/index.htm

Institute for NanoScience Design,
Osaka University

http://www.insd.osaka-u.ac.jp/index_e.html