TAIWAN TECH 應用科技研究所
Graduate Institute of Applied Science and Technology

奈米構築與奈米科技研究室

Nanoarchitecture and Nanotechnology Lab

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Chair Professor of Graduate Institute of Applied Science and Technology
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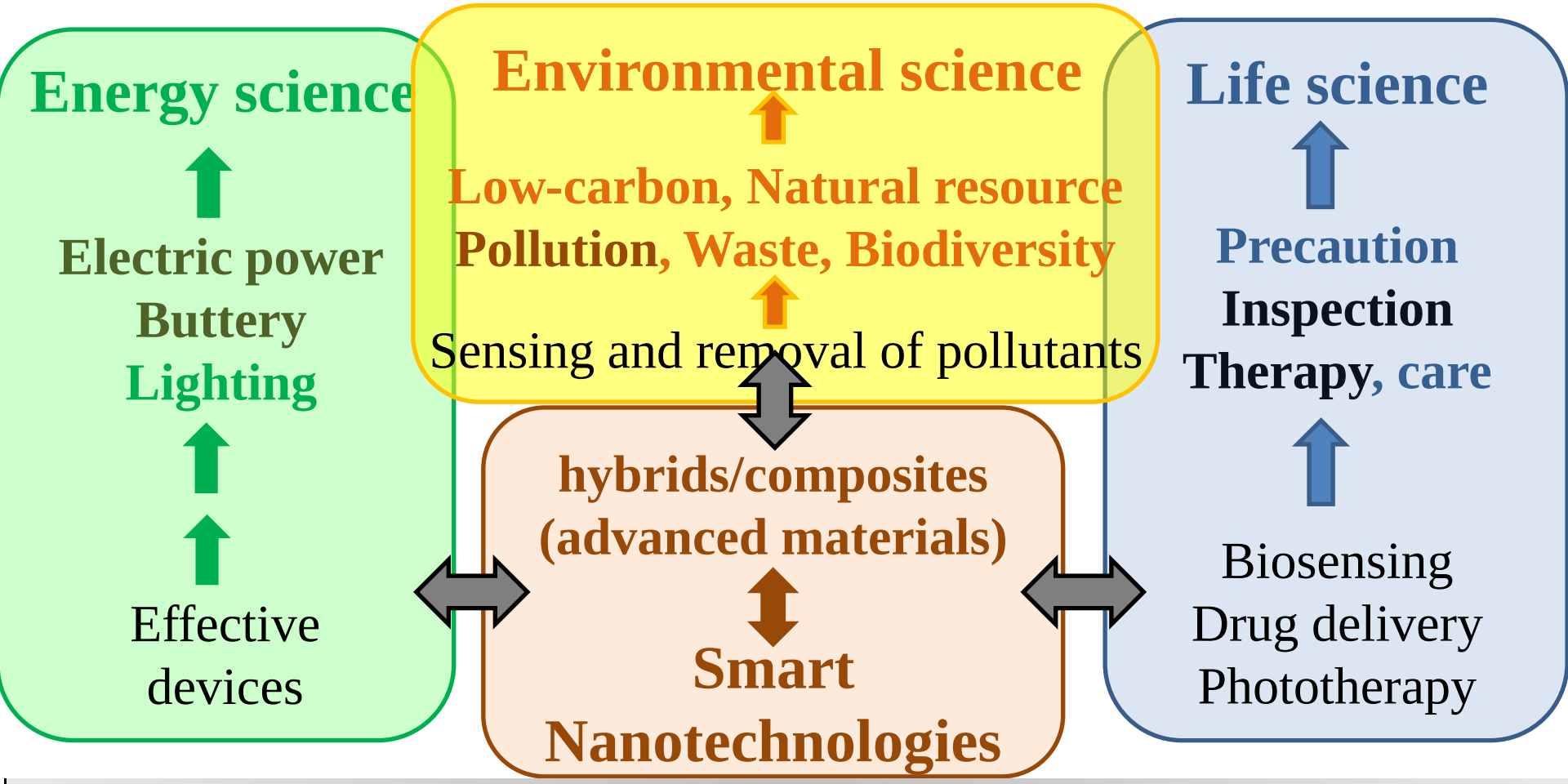
Motivation of research and education

Nowadays, in order to establish the environmentally low-load society and the comfortable human life, **“Innovative Science and Technology”**, that is, energy, life and environmental innovations must be focused.

When **advanced materials and smart nanotechnologies** are incorporated, the development of these research fields will be accelerated.

Advanced materials are valuable candidates as components on “Innovative Science”, and smart (innovative) nanotechnologies are indispensable to construct nanoarchitectures for “Innovative Science”.

Target Sciences



(key issues of research)

"Low-carbon Society"

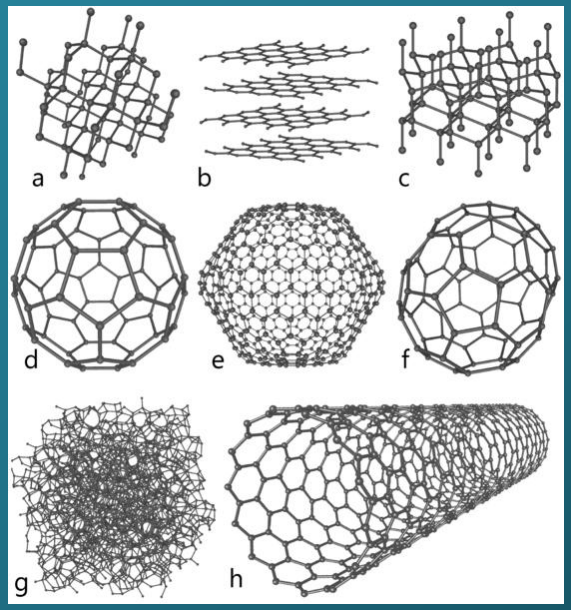
"3R (reduce, reuse, recycle) of Resources"

"Safe/secure Society and Healthy Life"

Advanced materials

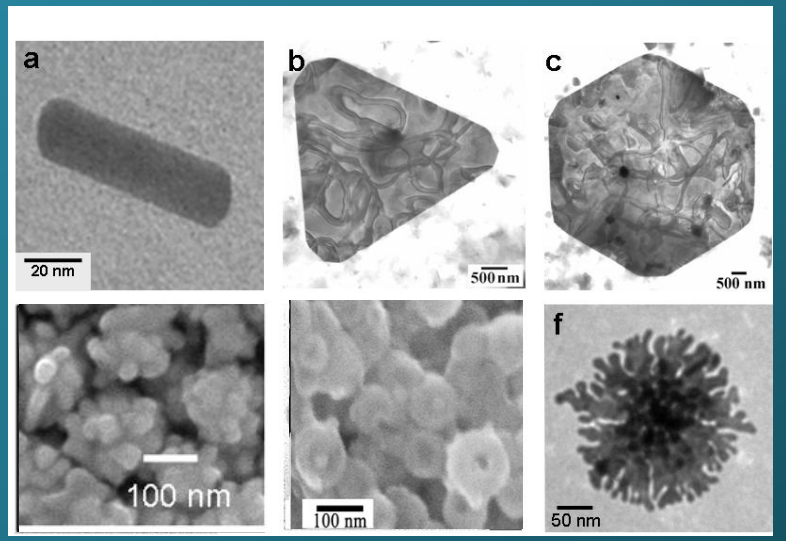
Carbon materials

Fullerene, carbon nanotube, etc.



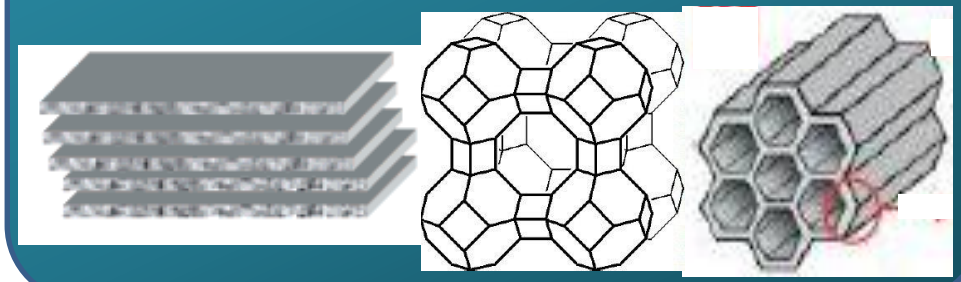
Metal-based materials

Metal, metal oxide nanoparticles, etc.



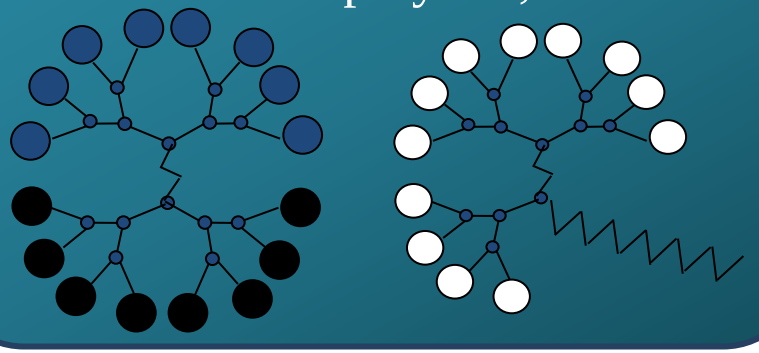
Mineral materials

Clay, zeolite, mesoporous silica, etc.



Polymer-based materials

Dendritic polymer, etc.



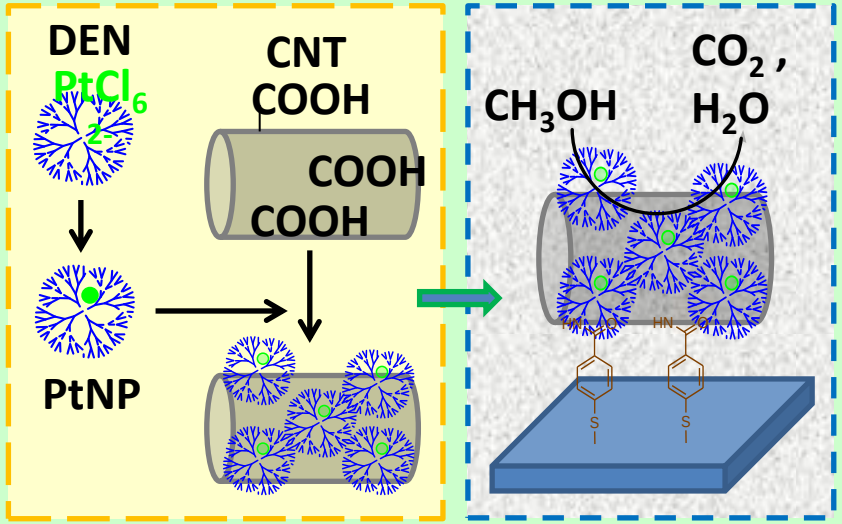
Strategy of research and education

Energy science and technology:

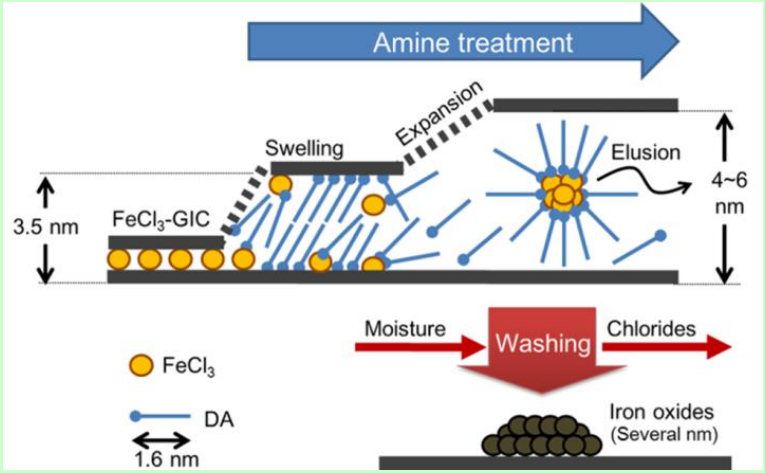
In the past years, there is growing interest in renewable energy generations, which are alternative of biofuel and atomic energy. Especially, the development of materials with high efficiency on solar cells and fuel cells is especially growing concern. The hybrid materials, which we have developed so far, are available as materials for such cells, and we will target our investigation to such directions. To be specific, **the hybrids consisting of metal oxide + carbon material or metal oxide + organic sensitizer** are valuable to solar cells and **the hybrids of Pt-embedded minerals or carbon materials** are utilizable for fuel cells in “energy science”.

Energy science and technology:

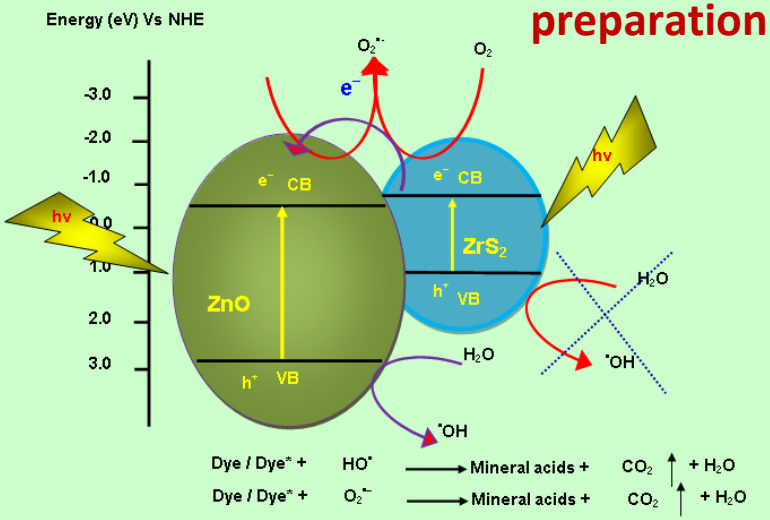
Fuel cell methanol detection



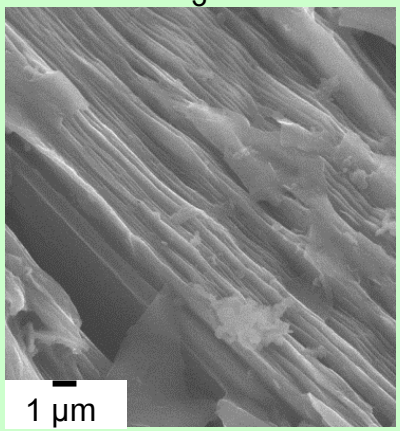
Solar/fuel cell graphene preparation



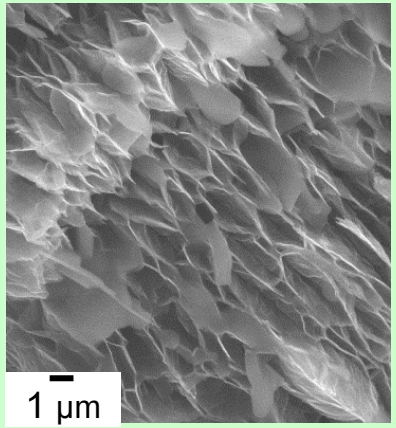
Solar cell metal oxide hybrid preparation



$FeCl_3$-GIC



Expanded graphite



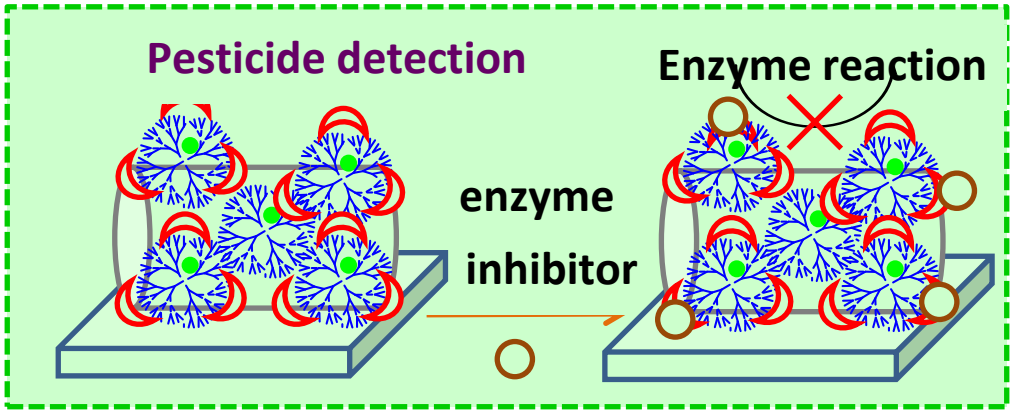
Environmental science and technology:

Pollutants have adverse effects on human health and environment, and their generation must be prevented, detected and deduced. Especially, CO_2 is a typical greenhouse effect gas and a causal agent of global warming. In order to remove pollutant gases including air pollutants (CO_2, NOx, and suspended particulate matter), endocrine disruptor (environmental hormone) and toxic gases (ex. dioxins), we must develop the advanced filters, which selectively adsorb pollutant gases. Then the filter must equip with the functionality to self-decompose pollutants. We accomplish "**the pollutant gas self-treatment membrane**". Sick house/building syndrome is also serious for residents, especially, for children with atopic hypersensitivity. We begin the development of the wall materials, which have the functions to decompose sick-house gases (ex. Building material-derived formaldehyde and preservative-derived volatile organic compounds) in "green science".

Environmental science and technology:

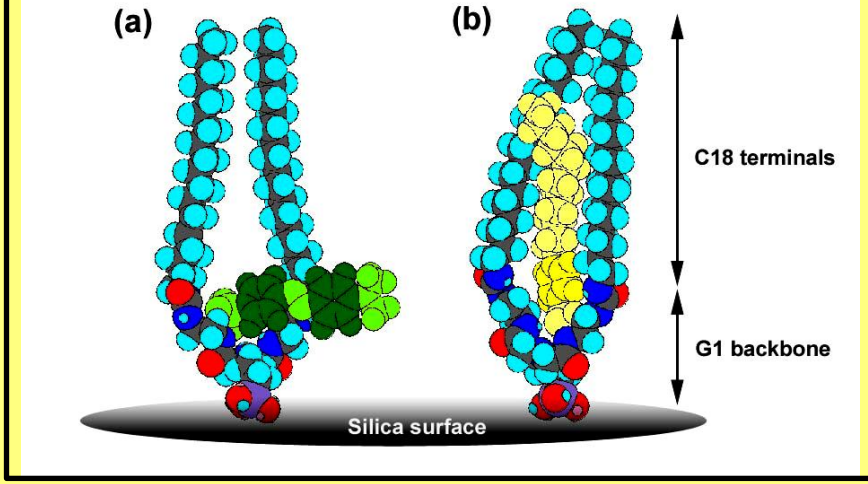
detection（sensors）

Enzyme-loaded biomedical electrochemical sensor



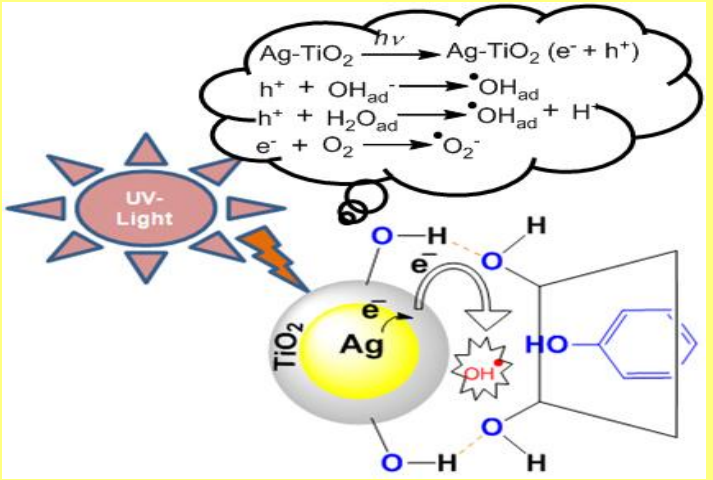
removal（adsorbents）

Amphiphile-coated porous silica adsorber

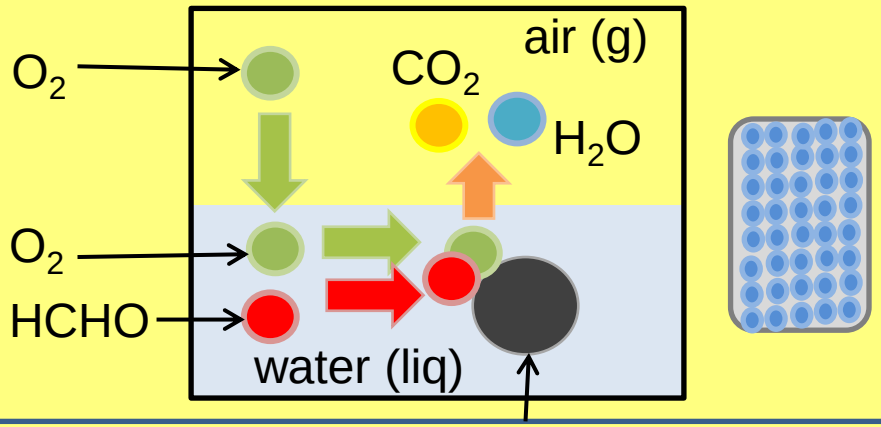


removal（catalytic decomposition systems）

Metal oxide hybrid catalysis



Pt catalysis in mesophorous material

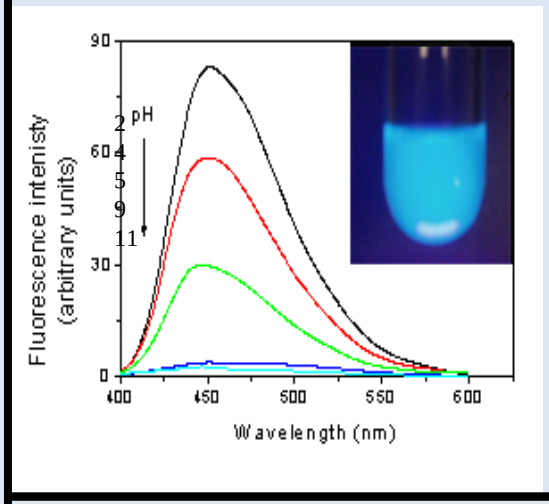


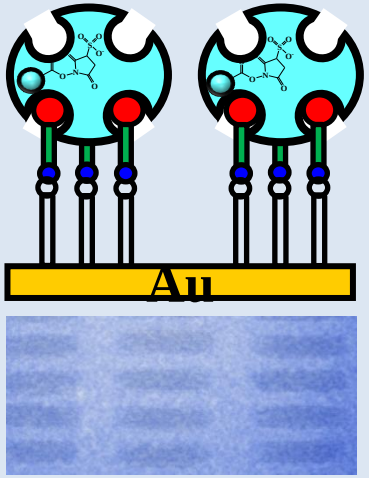
Biomedical science and Technology:

We target “life science”, because human population is exactly becoming an aging society and in the meanwhile there are many people who are forced unhealthy life in poverty society. In detail, we will develop our research in drug delivery systems and photothermal therapy. We will complete, at least, **carbon-based drug delivery systems and phototherapy-applicable non-spherical gold nanoparticles.** The advanced drug delivery systems must be administrable by drug targeting and, moreover, drugs must be distributed on only affected part. Then any artifice is required on the designing of drug delivery systems. The photothermal therapy is the less load medical treatment for patients. The practice issues are the development of adequate photothermal resources.

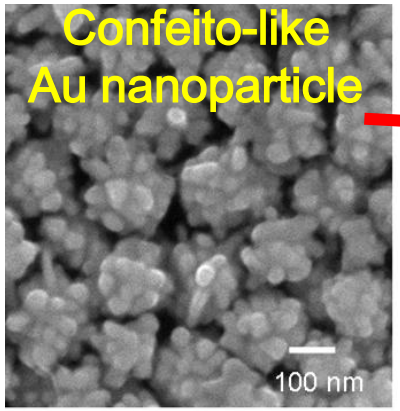
Biomedical science and Technology:

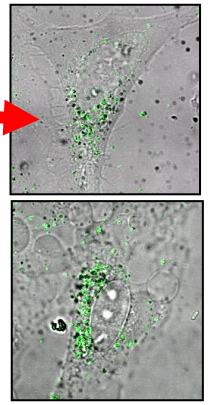
Fluorescence marker





Phototherapy

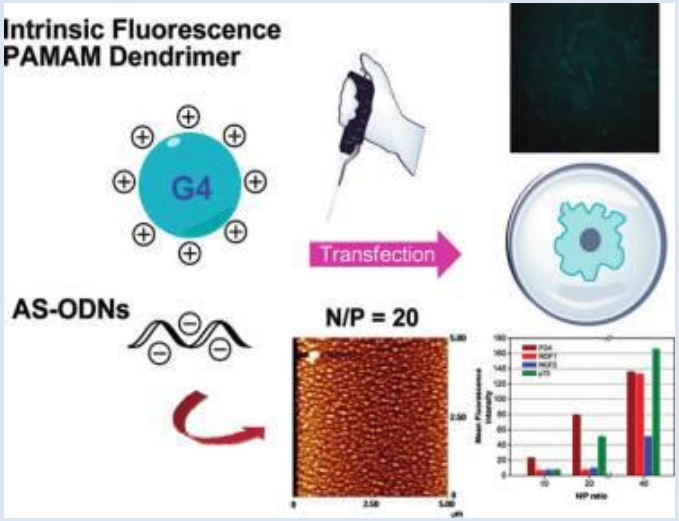




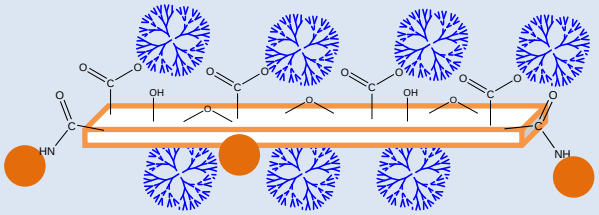
HeLa cells

Laser Irradiation @ 785 nm

gene therapy



phototherapy



HeLa Cells before irradiation

GO/DEN-OH/FA

Laser irradiation at 780 nm, 15 min

HeLa Cells after irradiation

Planned research projects

Project 1: Energy science and technology

Development of validated systems for energy production and storage

–Designing of architectures composed of **carbon materials** toward applications in energy production –

Project 2: Environmental science and technology

Architecting of advanced systems for air pollutant removal and decomposition

– Preparation of nanofiber films embedding catalysts and their applications to **air pollution degradation** –

Project 3: Biomedical science and Technology

Fabrication of nanobiotechnological systems for inspection and therapy

– Production of graphene-based drug delivery systems and their **phototherapeutic applications** –

Instrumentation

Electrochemical analysis

Cyclic voltammetry, Photo-electrochemical system

Microscopy

Fluorescence microscope, Transmission electron microscope, Atomic force microscope

Spectroscopy (surface enhanced spectroscopy)

UV-vis-NIR absorption spectrometer, Fluorescence spectrometer, Infrared absorption spectrometer, Raman scattering spectrometer

Surface science

Photolithography

Thermal analysis

Thermogravimetric analyzer

International collaboration

Project 2: Environmental science and technology

(2010-2012) DST/NSC(99-2923-M-011-002-MY3)

Collaboration with The M. S. University of Baroda, India

(2010-2013) Collaboration with Shimane University, Japan

(2010-2013) Collaboration with Okayama University of Science and Technology, Japan

Project 3: Biomedical science and Technology

(2010-2012) CSIC/NSC(99-2923-M-011-001-MY3)

Collaboration with IQAC-CSIC, Spain

(2010-present) Collaboration with Hyogo University, Japan

(2013 – 2015) Collaborative Research Agreement (MOA)

with University of Malaya, Malaysia

International activity

Chaired International conferences

1. **(2010) International Workshop** on "Novel Nanotechnology and Nanomaterials for "Science for Human"
2. **(2011) International Workshop** on "Novel Nanotechnology and Nanomaterials for "Science for Human"
3. **(2013) The 4th Asian symposium on Advanced Materials** – Chemistry, Physics & Biomedicine of Functional and Novel Materials (ASAM-4)

Nationality of members (since 2009)

Taiwan, Japan, India, Nepal, Thailand, Indonesia, Vietnam, Egypt, Russia, Malaysia