Life Sciences IT Environment Nanotech/Materials

Kyoto Nanotechnology Cluster

Kyoto

Establishment of “Kyoto as a Nanotechnology City” that achieves nanotechnology-based innovations through use of Kyoto’s unique characteristics and advantages

Cluster Vision

1. The primary goal is to provide nanotechnology-based solutions to the global environmental problems and health and living environment problems facing the human race in the 21st century.
2. Nanotechnology is used to enhance the international competitiveness of fields related to analysis, measurement, control, and materials that constitute the core of Kyoto industry.
3. An “All Kyoto” framework is established to seek drastic nanotechnology-based innovations for the region, exploiting achievements and experience in venture-business and new-business creation, through industry-academia collaboration for “fusion of tradition and advancement.”
4. Kyoto’s manufacturing industry, rooted in traditional handicrafts, is rejuvenated using nanotechnology.
5. Kyoto’s cultural resources are exploited to attract leading researchers, companies etc. from overseas to achieve “internal globalization.”

Project Overview

●Programs at Headquarters
- Seminars on applications and business deployment of advanced technologies: Kyoto Semiconductor Seminar and other seminars
- KYO-NANO outreach: Matching companies or introducing technology by dispatching researchers to companies
- Nanotechnology course for promotion of regional scientific technologies: Refresher Science Course (held jointly with the Kansai Branch of the Japan Society of Applied Physics)
- KYO-NANO spin-in operation: Practical seminar on use of large special equipment and other seminars
- Program in cooperation with industrial clusters (held jointly with the Neo Cluster Promotion Consortium): Seminar for creation of nature-friendly neo-materials
- KYO-NANO Society: Distribution of “Nano One-Point Memo”; Organization of industry-academia joint seminars; Publication of “Rakuchu-Rakugai Nanotech Tales (I, II)”

●R&D Themes

○Development of nanostructure surface treatment/analysis equipment
(Research rep.: Prof. Kazumi Matsushige, Kyoto University)
Development of advanced nanolevel electronic measurement/treatment equipment
Development of new gene analysis equipment
R&D on nanostructure control of advanced thin-film materials
Development of micro/nanostructure fabrication techniques

○Thin films and nanoparticles for industrial applications
(Research rep.: Prof. Shizuo Fujita, Kyoto University)
Development of nanostructure-based devices
Development of nanostructure-controlled ferroelectric molecular memory/sensors
Development of high-value-added SiC substrate
Development and application of metal ultrafine/nanoparticle fabrication techniques
Development of new materials using metal nanoparticles

○Establishment of photonics technology
(Research rep.: Prof. Kazuyuki Hirao, Kyoto University)
Development of new functional optical devices and optical measurement techniques based on micro/nanostructure control technology
Development of optical modulators using III-V semiconductor
R&D on new photonic nanostructure devices
Development of innovative photonic materials

○Nano-bio fundamental technologies
(Research rep.: Prof. Yoshiharu Kimura, Kyoto Institute of Technology)
Development of new polymer nano-bio technology
Development of structure-controlled devices based on nanostructure control technology
Development of biomolecule detection reagents

○Creation of nature-friendly nanomaterials
(Research rep.: Prof. Eiichiro Matsubara, Kyoto University)
Development of alternative transparent electrode materials for high-intensity LEDs
Development of surface-treatment techniques using nano-ultrathin membranes
Development of metal ultrafine/nanoparticle fabrication techniques for mesopatterning ink

○Project in cooperation with concerned ministries
(Research rep.: Prof. Shizuo Fujita, Kyoto University)
Development of next-generation terabit optical memory
Creation of a new market for wide-gap semiconductor applications
Development of simplified on-site diagnostic equipment
Business deployment of systems for catalytic reduction of NOx in emissions

Project Director
Tatsuro Ichihara

Former Vice President of Omron Corporation; serving as part-time president of Kyoto Shisaku Corporation since 2006

Toward Realization of a Human-centered Society

To ensure a life truly befitting humankind, the Kyoto Nanotechnology Cluster Headquarters think it essential to: (1) maintain and sustain global environmental conditions, and (2) minimize physical and psychological stresses on people under such conditions. Although achieving these goals through science and technology alone will be difficult, there is no time like the present in which to strive to meet these requirements. The Earth is currently in crisis in that we have been given one last chance to achieve these ends.
The only response that will allow us to survive this crisis and realize a sustainable society is to seek an appropriate balance future economic growth needed in the region with requirements (1) and (2). Conditions will not allow any of us to avoid this challenge. In the Kyoto region, we have been working on this challenge under the “All Kyoto” framework mainly through the Knowledge Cluster Initiative.
We believe that we should be able to find solutions to the mounting problems above by “getting back to the basics of science and technology.” To substantiate this belief, we are using nanotechnology as a fundamental technology in the categories of “the environment, life sciences, and materials;” these categories are linked to “measurement, analysis, and control,” which are industrial strengths of the Kyoto region. We are steadily working to achieve “Kyoto as a Nanotechnology City,” fueling the expectations of top-tier areas overseas as well.

Cluster Headquarters

○President…… Masao Horiba (Chief Advisor, Advanced Software Technology & Mechatronics Research Institute of Kyoto)
○Project Director…… Tatsuro Ichihara
○Chief Scientist…… Kazumi Matsushige (Vice President, Kyoto University; Vice President, Industry-Academia-Government Collaboration Headquarters, Kyoto University; Professor, Graduate School of Engineering, Kyoto University)
○Deputy Chief Scientist… Shizuo Fujita (Professor, Industry-Academia-Government Collaboration Center, Kyoto University)
○Science & Technology Coordinators… Akira Imada, Osamu Suzawa, Takahiko Oura, Tadahiko Horikiri, and Yasushi Mizutani

Core Organization

Advanced Software Technology & Mechatronics Research Institute of Kyoto (ASTEM)

Participating Research Organizations (Bold: Core Research Organization)

Industry…Abel Systems, Inc., ALGAN K.K., Alps Electric Co., Ltd., NK-Research, Oike & Co., Ltd., Omron Corporation, Kyocera Corporation, Kyoto Instruments Co., Ltd., Gunze Co., Ltd., Chemco Scientific Co., Ltd., Konica Minolta Technology Center, Inc., Samco, Inc., Sixon Ltd., Shimadzu Corporation, Shinwa Chemical Industries, Ltd., Ceramic Forum Co., Ltd., Daikin Industries, Ltd., RebornTK, Ltd., Toyobo Co., Ltd., Toyoda Gosei Co., Ltd., Towa Japan Co., Ltd., Nakashima Propeller Co., Ltd., Nichia Corporation, Bioface Co., Ltd., Harima Chemicals, Inc., Hitachi Chemical Co., Ltd., Hitachi, Ltd., Fukuda Metal Foil & Powder Co., Ltd., Horiba, Ltd., Mutual Corporation, Musashino Chemical Laboratory, Ltd., Murata Manufacturing Co., Ltd., Rohm Co., Ltd., etc.
Academia…Kyoto University **(Graduate School of Engineering; Industry-Academia-Government Collaboration Center),** Kyoto Institute of Technology **(Graduate School of Science and Technology),** Ritsumeikan University **(Research Organization of Science and Engineering),** Doshisha University (Graduate School of Business), Japan Advanced Institute of Science and Technology, Iwate University, Kobe University, the University of Tokushima, etc.
Government…National Cardiovascular Center Research Institute, National Institute of Agrobiological Sciences, etc.

Main Results

1. Successful development of world’s first high-efficiency green semipolar GaN LED
<Kyoto University + Nichia Corporation>
The high-efficiency near-UV/blue nitride-semiconductor light-emitting diode (LED) is already on the market. This conventional LED has problems in controllability and luminous efficiency in the long-wavelength range of green to red long-wavelength range. A The world’s first high-luminosity green LED, with drastically improved luminous efficiency, has been successfully developed by a joint research group of Nichia Corporation and Professor Yoichi Kawakami and Associate Professor Mitsuru Funado of the Department of Electronic Science and Engineering, Graduate School of Engineering, Kyoto University.
The developed LED consists of an InGaN/GaN quantum well structure formed on a field-distortion-free GaN crystal substrate, as shown in the figure on the right.

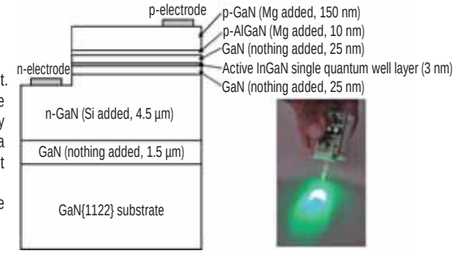

Figure: Element Structure and Light Emission of Developed Green LED

2. Metal nanoparticles that do not require a protective coating
<Kyoto University + Fukuda Metal Foil & Powder + Hitachi Chemical>
An innovative process for manufacturing a silver/copper nanoparticle dispersion liquid, which can be used as a metal nanoparticle ink to form conductors, has been established by a joint research group of Fukuda Metal Foil & Powder Co., Ltd., Hitachi Chemical Co., Ltd. and Associate Professor Mitsuo Kawasaki of the Department of Molecular Engineering, Graduate School of Engineering, Kyoto University. The dispersion liquid manufactured by this process maintains stable dispersion and oxidation resistance at a high density of up to at least about 30 wt%.
The companies participating in this joint research plan to deploy this dispersion liquid as a wiring material for use in printable electronics. The photo on the left shows a silver nanoparticle dispersion liquid (approx. 20wt%) that does not require a protective coating; the photo on the right shows a TEM image of silver nanoparticles. Before this development, a dispersion liquid of this type was not available anywhere in the world.

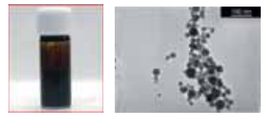

Figure: Silver Nanoparticles

3. Development of an ambient-temperature CO oxidation catalyst <Kyoto University + Kyoto Nano Chemical>
An innovative metal-nanoparticle carbon monoxide (CO) catalyst has been developed by a joint research group of Kyoto Nano Chemical Co., Ltd. and Professor Kazuhiro Mae of the Department of Chemical Engineering, Graduate School of Engineering, Kyoto University. Even at ambient temperatures, the developed catalyst functions effectively to oxidize CO from a variety of sources, such as various air conditioning systems, air purifiers, gas heat pumps, and fuel cells. This catalyst consists of highly dispersed metal nanoparticles on an iron oxide support manufactured by a newly developed method. The research group intends to use this catalyst to develop an easily commercialized CO remover.

Figure: CO Catalyst

Future Goal for Kyoto Nanotechnology Cluster: Realization of a Human-Centered Society