



# Symposium on Environmental and Medical Applications of Photo-induced Energy Transfer Processes in Nanostructures (EMAPET-Nano)

**Venue: Noyori Hall, Nagoya University**

**November 27<sup>th</sup> 2025 (Thursday)**

**Scope/objectives:** This symposium will focus on discussing state-of-the art and potential for applications of photothermal materials, in the fields of catalysis, electrocatalysis, water remediation, and biomedicine, more precisely effective photothermal materials, including metal-, carbon- and silicon-based nanostructures, such as individual nanocrystals, porous materials, nanodot assemblies, and nanostructures. The potential of such nanostructures in diverse multidisciplinary fields, such as plasmonic-induced catalytic and electrocatalytic processes in hydrogen generation and CO<sub>2</sub> reduction into added-value chemicals or fuels, and bio-medicine (photothermal treatment of bacterial infections and tumors), will be discussed. The symposium will aim at gathering people from different disciplines (materials science, physics, chemistry/electrochemistry, biology and medicine) to exchange on recent advances on photothermal materials, as well as identifying the fundamental aspects that still need to be clarified and challenges to be tackled.

## **PROGRAM**

**13:00-13:05 Opening (Bernard Gelloz)**

**13:05-14:05 Keynote presentation by Rabah Boukherroub, CNRS, IEMN, France.**

**“Photothermal materials in catalytic processes, water treatment, and biomedical applications”**

Photothermal materials have received increasing interest and emerged as transformative components in various fields (catalysis, environment, biomedicine), owing to their ability to efficiently convert light to heat. In photothermal catalysis, recognized as an alternative to conventional photocatalysis and thermocatalysis, these materials enhance various catalytic processes like water splitting and pollutant degradation by lowering the activation energy and boosting reaction rates.

For water treatment, photothermal materials, structured in the form of membranes or aerogels, promote water evaporation under solar irradiation, offering a viable and sustainable solution for the ongoing global challenges of water scarcity and clean energy shortage.

In biomedicine, photothermal materials can efficiently convert light energy into heat to achieve localized thermal therapy for specific cells or tissues, offering numerous benefits such as minimal invasiveness, high selectivity, and precise targeting. Moreover, photothermal materials can serve as molecular imaging probes and smart drug carriers, integrating multiple functions such as bioimaging and drug delivery to realize the visualization and controlled release of therapeutic processes.

In this presentation, I will summarize our recent results on the preparation of photothermal materials, their applications in environment and biomedicine, discuss current challenges, and outline future directions for the implementation of photothermal materials in the related fields.

**14:05-14:40 Presentation by Bernard Gelloz, Nagoya Univ.**

**“Silicon nanostructures and their potential for light emission and energy transfer/harvesting”**

Silicon is well known for its use in microelectronics. Crystalline silicon can be mass-produced in bulk with excellent purity. Silicon nanostructures (SiNano) have been shown to be environment-friendly, non-toxic, and bio-compatible. When sufficiently small, quantum-mechanical effects emerge in SiNano, giving rise to new properties, such as efficient visible emission, and various optical behaviors. SiNano can be produced in the form of thick porous layers (up to hundreds of micrometers), opening the possibility of a wide range of applications, like chemical sensing, filtering, and photonics. In particular, its ability to absorb, harvest or transfer energy from incident light makes it a potential material for applications using solar energy photoconversion. In this presentation, I will introduce some SiNano materials and show some examples of its properties relevant to the symposium topics.

**14:40-15:25 Invited presentation by Qian Wang, Nagoya Univ.**

**“Scalable and Effective Artificial Photosynthetic Materials for Solar Fuel Production “**

The development of sunlight-driven water splitting or CO<sub>2</sub> reduction systems with high efficiency, scalability, and cost-competitiveness is a central issue in the mass production of fuels and energy-rich chemicals. We designed and developed all-solid-state devices, that is, photocatalyst sheets for photocatalytic water splitting and CO<sub>2</sub> reduction. These photocatalyst sheets produced hydrogen via overall water splitting with high efficiency or reduced CO<sub>2</sub> into formate/acetate with high selectivity, setting new benchmarks in the field of photocatalytic solar fuel production. Moreover, the photocatalyst sheet design is well-suited to large-scale applications. Our study offers a novel and versatile strategy toward sustainable and practical solar fuel production.

**15:25-15:55 ~ Coffee break (*1F near entrance; with drinks/snacks*)**

**15:55-16:40 Invited presentation by Kazuhiro Fukami, Kyoto Univ.**

**"Functionalized graphene nanoribbon as a catalyst for chemical etching of silicon"**

Metal-assisted chemical etching of silicon (MacEtch) has garnered significant attention as a surface processing technique of silicon. Although oxidizing agents in etchant such as H<sub>2</sub>O<sub>2</sub> exhibit low reactivity on silicon surfaces, they react efficiently with metal surfaces deposited on silicon. This leads to selective etching at the interfaces between the metal and silicon, making MacEtch a promising method for site-selective silicon etching. However, since metals can become impurities in silicon, MacEtch has not yet been established as a practical processing technique. To address this issue, we have been developing a metal-free chemical etching of silicon using carbon materials as catalysts, thereby eliminating the risk of metal contamination.

Carbon materials are generally considered to have low catalytic activity. To enhance their catalytic performance, we focus on graphene nanoribbons (GNRs), which feature engineerable edges that can, in principle, be functionalized with various chemical groups. In this study, we synthesized GNRs having butoxy groups at their edges (EC-GNRs) via electrochemical polymerization. Our results show that EC-GNRs significantly enhance the silicon etching rate compared to other carbon materials such as graphene, graphene oxide, and carbon nanotubes.

**16:40-17:25 Invited Presentation by Hiroaki Tsuchiya, Univ. of Osaka**

**“TiO<sub>2</sub> nanotubes-based photocatalysts”**

Recently, anodization has attracted much attention as it can fabricate nanostructured oxide layers on various metal and alloy substrates. In particular, anodic TiO<sub>2</sub> nanotubes have been extensively studied due to their wide range of applications such as solar cell, electrochromic devices and photocatalytic hydrogen evolution. For the hydrogen evolution, precious metal nanoparticles such as platinum and gold are often decorated on anodic TiO<sub>2</sub> nanotubes to facilitate charge transfer. To achieve such decoration, various approaches have been proposed. We propose alloy anodization where Ti alloys containing an alloying element are used. In the alloy anodization, the fabrication of TiO<sub>2</sub> nanotubes and the decoration of the tubes with nanoparticles of the alloying element can be simultaneously realized, that is, when Ti alloys containing platinum as alloying element are used, platinum nanoparticle decorated TiO<sub>2</sub> nanotubes can be formed. Platinum nanoparticle decorated TiO<sub>2</sub> nanotubes have been demonstrated to enhance photoinduced hydrogen evolution. In the present work, anodization of Ti alloys containing platinum and gold, the morphology and hydrogen evolution performance of resulting TiO<sub>2</sub> nanostructures.

**17:25-17:30 Closing remarks (Bernard Gelloz).**

**17:30-18:00 Free discussion (*IF near entrance; with drinks/snacks*), leave the venue.**

**Free of charge. Everybody is welcome. Please register by Nov. 20<sup>th</sup> at:**

<http://www.j-group.phys.nagoya-u.ac.jp/EMAPET-Nano.html>

Chair/問い合わせ：物理 J-研 Gelloz Bernard (bernard.gelloz@nagoya-u.jp)