大阪大学 OSAKA UNIVERSITY

rijksuniversiteit groningen

INSD NanoScience Video Exchange Lectures (2023, Groningen-Osaka)

These lectures are held as a part of **"Fundamental and functional properties of nanomaterials"** in top Master NanoScience in Groningen and as **"International Exchange Lectures on Nanoscience and Nanotechnology A"** in INSD Nano Program in Osaka. The program is also shared by University of Science-Malaysia, King Mongkut's Institute of Technology Ladkrabang-Thailand, and Institute for Materials Science VAST-Vietnam.

The lectures except for October 13th start on the following Fridays at 9:00 in the morning (Groningen time), that is, at 16:00 or 17:00 in the afternoon (Osaka time).
[NOTE The Netherlands switches from summer time (day light saving time) to winter time on the night of October 29th (Sun) 01:00 (UTC) 2023.]

Lecture 0

Friday, 13 Oct. 2023
Osaka time: 16:00-18:15 (no exchange lecture from Groningen)

Prof. Tadashi Itoh, Institute for NanoScience Design (speaks 16:00-18:15 (O))
(Field: solid state physics, semiconductor nanocrystal (quantum dot), optical properties)
Title: Introduction, Photophysics of quantum dots.
(Together with video address and Nobel-Prize lecture given by Prof. Benard L. Feringa)
Abstract: Electronic excited states (excitons) in semiconductor nanocrystals show peculiar quantum size effects which exhibit various kinds of characteristic optical properties; blue shift and splitting of the exciton energy states, rapid radiative decay, ultrahigh speed giant optical nonlinearity, highly efficient lasing, etc.

Lecture 1

Friday, 20 Oct. 2023
Osaka time: 16:00-18:00
Groningen time: 9:00-11:00

Chair: Prof. Thomas Jansen
Prof. Jan Anton Koster (9:00-9:55 (G) / 16:00-16:55 (O))
(Field: Photophysics and optoelectronics, semiconductors and devices, thermoelectrics)
Title: Organic semiconductors for thermoelectrics
Abstract: In this lecture, I will introduce organic semiconducting materials and will briefly review their charge transport properties. Next, I will emphasize their promise for thermoelectric applications.

Chair: Prof. Yoshikata Nakajima
Prof. Hidekazu Tanaka, SANKEN (Institute of Scientific and Industrial Research)
(17:00-17:55 (O) /10:00-10:55(G))

(Field: electronic/magnetic/optical properties of oxide thin films and their nanostructures)

Title: Basics and applications of electronic phase change oxides

Abstract: Phase change materials enable rapid switching between different structural phases, resulting electric properties switching. Some classes of materials are interesting on switching between different electronic/spin phases itself, such as Mott insulator- metal transition, and their electronic phase change would produce new classes of devices. This part of the lecture will focus on electronic phase change phenomena on transition metal oxides.

Topics will be included, ・Physics and material science on structural and metal/insulator transition of VO_2 as a prototype material, ・Brief review of phase change phenomena on transition metal oxides (vanadate, manganite, nickelate, ferrite, ruthenate, etc.), ・External field induced electronic phase change phenomena, ・Switching/Memristive /Biology-inspired /Photonic devices based on electronic phase change materials.

Lecture 2

Friday, 27 Oct. 2023

Osaka time: 16:00-18:00
Groningen time: 9:00-11:00

Chair: Prof. Yoshikata Nakajima

Prof. Syoji Ito, Graduate School of Engineering Science (16:00-16:55 (O) /9:00-9:55(G))
(Field: laser manipulation, single-molecule detection)

Title: Single-molecule fluorescence detection: methods and applications

Abstract: The lecture starts with the history of single-molecule fluorescence detection (SMFD) and the introduction of typical methods of SMFD: confocal and wide-field microscopies. Then several important applications of SMFD are shown, e.g. fluorescence correlation spectroscopy, single-molecule tracking, and super-resolved fluorescence imaging.

Chair: Prof. Thomas Jansen

Prof. Jagoda Sławińska (10:00-10:55 (G) / 17:00-17:55 (O))
(Field: computational materials science, spintronics)

Title: Spin-orbit-related phenomena for energy-efficient electronic devices

Abstract: In this lecture, I will discuss the fundamentals of spintronics (spin-based electronics) which employs the electron's spin, along with its charge, to carry and process information in a more energy-efficient way. Spin-orbit interaction, despite being small in magnitude, is very powerful and drives several intriguing phenomena that allow for different functionalities suitable for novel electronic devices. After explaining the basic principles and challenges of spintronics, I will focus on materials for conversion between charge and spin currents and their computational design via first-principles calculations.

Lecture 3

Friday, 10 Nov. 2023

Osaka time: 17:00-19:00
Groningen time: 9:00-11:00 (in winter time)

Chair: Prof. Yoshikata Nakajima

Prof. Yoshitada Morikawa, Graduate School of Engineering (17:00-17:55 (O) / 9:00-9:55(G))
(Field: computational science, surface science, DFT, machine learning, CO_2 hydrogenation)

Title: Computational Materials Design for Surfaces

Abstract: Chemical reactions at surfaces and interfaces play important roles in wide ranges of applications such as heterogeneous catalysis, electrochemistry, fuel cells, batteries, etching processes of semiconductor materials, and so on. In this lecture, I will present density functional theory (DFT) investigation and prediction of hydrogenation of CO_2 over Cu catalyst. To clarify reaction mechanisms and to identify important factors governing the reactivity of CO_2 on solid surfaces are very important to develop more efficient catalysts or catalytic processes for utilization of CO_2. Although DFT simulations are quite useful to investigate atomic-scale phenomena, the time scale of the simulations is limited to tens of ps and the length scale to nm. I will discuss how to extend the length-scale and time-scale of DFT simulations by combining DFT calculations with machine learning techniques. I will show that it is now possible to clarify the formation process of Cu–Zn surface alloy, which has been extensively studied for the clarification of the true active site of $Cu/ZnO/Al_2O_3$, the industrial catalyst for methanol synthesis which remains under controversy.

Chair: Prof. Thomas Jansen

Prof. Loredana Protesescu (10:00-10:55 (G) / 18:00-18:55 (O))
(Field: nanomaterials)

Title: Functional inorganic nanomaterials

Abstract: As a special class of materials, inorganic nanomaterials consist of particles of metals, metal oxides, metal chalcogenides (metal sulfides, selenides, or tellurides) or halide perovskites with at least one dimension in the 1- to 100-nanometer (10^{-9} m) range. These nanomaterials are highly interesting because they exhibit properties that bridge the gap between bulk and molecular structures. Unlike their bulk counterparts, nanomaterials exhibit tunable size- and shape-dependent optical, electronic, and magnetic properties. Because of these unique properties, nanomaterials are being explored to address key global challenges in areas such as energy conversion, catalysis, medicine, sensing, and environmental remediation.

Lecture 4

Friday, 17 Nov. 2023

Osaka time: 17:00-19:00
Groningen time: 9:00-11:00 (in winter time)

Chair: Prof. Yoshikata Nakajima

Prof. Yasuhiro Nakazawa, Graduate School of Science (17:00-17:55 (O) /9:00-9:55(G))
(Field: Molecular superconductors, electron correlations, thermodynamics)

Title: Molecular superconductors and their thermodynamics

Abstract: The organic-molecules-based conductors and superconductors give a variety of physical features of itinerant π-electrons released from molecular orbitals. Fascinating physical and chemical features related to the electron correlations, electron-phonon interactions emerge in them with various manners, since the energy scale of spin, charge, and phonon degrees of freedom are in the similar order. The lecture focus on why the interesting conducting states, especially superconductivity with unconventional characters appear in them and how we can characterize the electronic properties by means of micro-crystal thermal measurements.

Chair: Prof. Thomas Jansen

Prof. Rifka Vlijm (speaks 10:00-10:55 (G) / 18:00-18:55 (O))

(Field: super-resolution microscopy, STED, STORM, MINFLUX)

Title: Super-resolution light microscopy

Abstract: For decades it was believed that light microscopy could not be used to discern structures closer together than the diffraction limit (half the wavelength of light ~250nm). With the groundbreaking invention of STimulated Emission Depletion microscopy, and later STORM (Stochastic Optical Reconstruction Microscopy) and other methods, now it became possible to visualize even in living cells structures much smaller than the wavelength of the used light. The latest development (MINFLUX nanoscopy) even allows imaging in living cells with an effective point spread function of only a few nanometers. In this lecture the working principles of super-resolution microscopy techniques are explained, and the benefits and drawbacks of each of these are discussed. By identifying the bottlenecks of our methods a suitable match between research question and applied technique can be made. Furthermore, by identifying which bottlenecks are technical rather than fundamental, new developments can be stimulated. We here discuss some of the latest developments significantly driving the field of light microscopy.