UNIVERZITA J. E. PURKYNĚ V ÚSTÍ NAD LABEM
Fakulta životního prostředí

INVITATION TO A SERIES OF LECTURES ON 16. 1. — 21. 1. 2023

by Prof. Spyros N. Yannopoulos

Foundation for Research and Technology – Hellas, Institute of Chemical Engineering Sciences, (FORTH/ICE–HT), Patras, Greece

Department of Chemistry, University of Patras, Patras, Greece

PROGRAMME

9–11 a.m., Monday 16, January 2023, CPTO building, Auditorium 1.01

INTRODUCTION TO THE RESEARCH ACTIVITIES OF FORTH/ICE-HT (NANOTECHNOLOGY, ADVANCED MATERIALS, ENERGY AND ENVIRONMENT, BIOSCIENCES AND BIOTECHNOLOGY.

Prof. Yannopoulos will also highlight the key role of PhD students in FORTH/ICE-HT.

2–4 p.m., Monday 16, January 2023, CPTO building, Auditorium 1.01

INTRODUCTORY REMARKS ON LIGHT-MATTER INTERACTION

The fundamental ideas and mechanism of light and matter interaction will be introduced, emphasizing the phenomena related to absorption, emission and scattering. The basic principles of Rayleigh scattering and the role of the scattering wavevector will be presented.

9–11 a.m., Tuesday 17, January 2023, CPTO building, Auditorium 1.01

INTRODUCTION TO RAMAN SCATTERING: PRINCIPLES

The basic principles of vibrational spectroscopy will be presented. The main topics include: selection rules for Raman scattering and IR absorption, the harmonic and anharmonic oscillator, the types of Raman scattering (resonance etc.), the “classical” description of the Raman effect, and the role of polarizability tensor in the Raman effect.

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Národní plán obnovy
MINISTERSTVO ŠKOLSTVÍ, MLÁDEŽE A TĚLOVÝCHOVY

9–11 a.m., Wednesday 18, CPTO building, Auditorium 1.01

RAMAN SPECTROSCOPY: INSTRUMENTATION

The lecture contains details about (i) the use of the polarization analysis and the depolarization ratio, to understand the symmetry of vibrational modes; (ii) corrections of raw Raman spectra; (iii) handling of Raman spectra for non-crystalline solids; (iv) basic parts of a Raman spectroscopic set-up; (v) brief survey on topics such as confocal and surface-enhanced Raman scattering.

9–11 a.m., Thursday 19, CPTO building, Auditorium 1.01

STATIC LIGHT SCATTERING

The lecture contains principles of static light scattering from dilute suspensions of small and large particles, details on the role of osmotic pressure in light scattering, methods for the estimation of the radius of gyration and the molecular weight using the Zimm plot, and information about the structure factor of particles with various shapes.

9–11 a.m., Friday 20, CPTO building, Auditorium 1.01

DYNAMIC LIGHT SCATTERING

The lecture will introduce principles related to thermal fluctuations in liquids and their role in light scattering, as well as the concepts of relaxation, Brownian motion and stochastic functions, such as density fluctuations. Various ways to analyse DLS data for estimating the particle size will be discussed in relation to the limitations of each method.

9–11 a.m., Saturday 21, CPTO building, room 5.25

GOOD TEACHING AND LABORATORY PRACTICE FOR DIFFERENT TYPES OF SCATTERING METHODS

The invitation is by Dr Jiri Orava (Faculty of Environment); jiri.orava@ujep.cz

The series of talks is a part of the preparation of the new doctoral study programme "*Environmental and Biomaterials Sciences*" supported by **NPO_UJEP_MSMT_16588/2022**.

BRIEF RESEARCH SYNOPSYS OF PROF. YANNOPOULOS

Prof. Yannopoulos has an *h*-index of 35 and published over 170 peer-reviewed papers.

His group pursues strategic collaboration with academia and SMEs to exploit synergies to reach high TRL outcome with exploitable impact, covering applications such as flexible electronics, energy harvesting/conversion/storage, sensors, photocatalysis, and photonics.

(i) application of bottom-up and top-down synthesis routes (wet chemistry, vapour deposition, etc.) to up-scale the growth of low-dimensional nanocrystals at large areas with controlled morphology,

(ii) exploration of novel synthesis routes of (nano)materials, based mainly on inherently scalable laser-assisted fabrication, which are compatible with sustainability and circular economy policies,

(iii) light-mediated manipulation of photosensitive amorphous semiconductors,

(iv) application of various types of nanomaterials into devices to understand the fundamental issues of structure/morphology, to enable the rational control of properties and functionalities.

[1] Nanomaterials – Nanoscience – Nanotechnology

a. Laser-assisted fabrication of graphene-based nanomaterials from **inorganic** (metal carbides**)** and **organic** (polymers and biomass-based raw materials) precursors at ambient conditions:
- **Graphene-based nanocomposites**, SiC/nc-Si/graphene for electrochemical applications.
- R2R-compatible laser-assisted *in-situ* **GO reduction** on textiles/flexible substrates
- Laser-scribed-**graphene electrodes** for energy harvesting (triboelectric nanogenerators for batteryless flexible electronics), and electrochemical energy storage devices.

b. Rational bottom-up synthetic routes (wet chemistry and CVD) for the controlled growth of **1-D** nanostructures and heterostructures, i.e., core/ sheath nanowires:
- **Energy conversion:** optimizing the anode and cathode active materials for dye-sensitized solar cells; improving the anode nanostructures of photo-electrochemical devices for H2 evolution
- **Photocatalytic applications:** defect and morphology engineering of nanocrystals for waste-water treatment; advancing immobilized photocatalysts for large-scale reactors
- **Gas sensors:** synthesis of nanostructured heterostructures to achieve high sensitivity/selectivity and device operation at room temperature for dangerous gasses, such as CO
- **Nanophotonics:** optimizing the morphology of nanowire arrays for realizing SERS substrates; control luminesce properties; antireflection performance.

c. CVD and PVD growth of **2-D** few-layer transition metal di-chalcogenide (TMDC) crystals
- Direct PVD growth of 2-D TMDC crystals on TM foils for catalytic applications
- CVD growth of vertical heterostructures (heterojunctions of different 2-D materials)
- Combinatorial growth of 1-D and 2-D materials in core-sheath structures for solar energy conversion (photocatalysis, water splitting)
- Nanoscale engineering 2-D crystals for tribological applications

d. Nanofluids for power transformer oils with enhanced thermal and dielectric properties
Synthesis and long-term stability studies of nanofluids for power transformers

[2] Glasses and Glass transition

e. Studies of structure and dynamics of a wide range of non-crystalline solids
A host of experimental techniques (all kinds of light scattering; synchrotron radiation, surface sensitive techniques) are employed, including structural probes and optical spectroscopies to study dynamics and collective phenomena in glasses, supercooled liquids and melts.

f. Athermal photoinduced phenomena and phase changes in amorphous semiconductors
A number of photoinduced structural changes in chalcogenide materials are explored using structure-probing techniques to better understand chalcogenide glasses (athermal photoplastic phenomena, athermal reversible photo-crystallization, phase-change materials).

[3] Development of new techniques

- Demonstrated the construction and feasibility of a laboratory prototype for infra-red photon correlation technique using near-IR lasers, suitable for densely colored liquids (chalcogenides).
- Established a non-invasive methodology, based on DLS, for non-invasive and reliable early diagnosis of eye diseases, e.g., lens cataract.

More information about Prof. Yannopoulos' activities can be found here:
https://www.iceht.forth.gr/en/people/s-n-yannopoulos/