6th Raman Workshop

7 - 9 June 2023
ETH Zürich Hönggerberg

ETH zürich

MaP Doctoral School eth zurich

supported by:

25 YEARS OF EPJ .org
your physics journal

RENISHAW
apply innovation™

Empa
Materials Science and Technology

HORIBA
Scientific

KEYENCE

STAT PEEL®
MATERIAL-SELECTIVE DETECTION SYSTEM

OXFORD INSTRUMENTS

WITec

WELCOME

The ETH Raman Workshop 2023 will base on previous successful editions (2021, 2019, 2018, 2017 and 2016), fostering the network of active Raman researchers both in Switzerland and abroad. The workshop features top-profile scientists from all over the world, aimed at providing insights into the various techniques and applications of Raman spectroscopy in science and engineering. We will bring together researchers from different research fields and with different backgrounds, to strengthen collaborative research, facilitate the exchange of ideas, and to find solutions for the persistent challenges of the science of today and tomorrow.

This workshop is targeted at doctoral students affiliated with MaP Doctoral School and other young researchers who already use, or plan to use Raman spectroscopy to address scientific challenges. We believe that communication among participants is key to the success of the workshop. Thus, active participation is strongly necessary to make the most of the workshop.

The organizational committee would like to thank you for your active participation!

SPONSORS

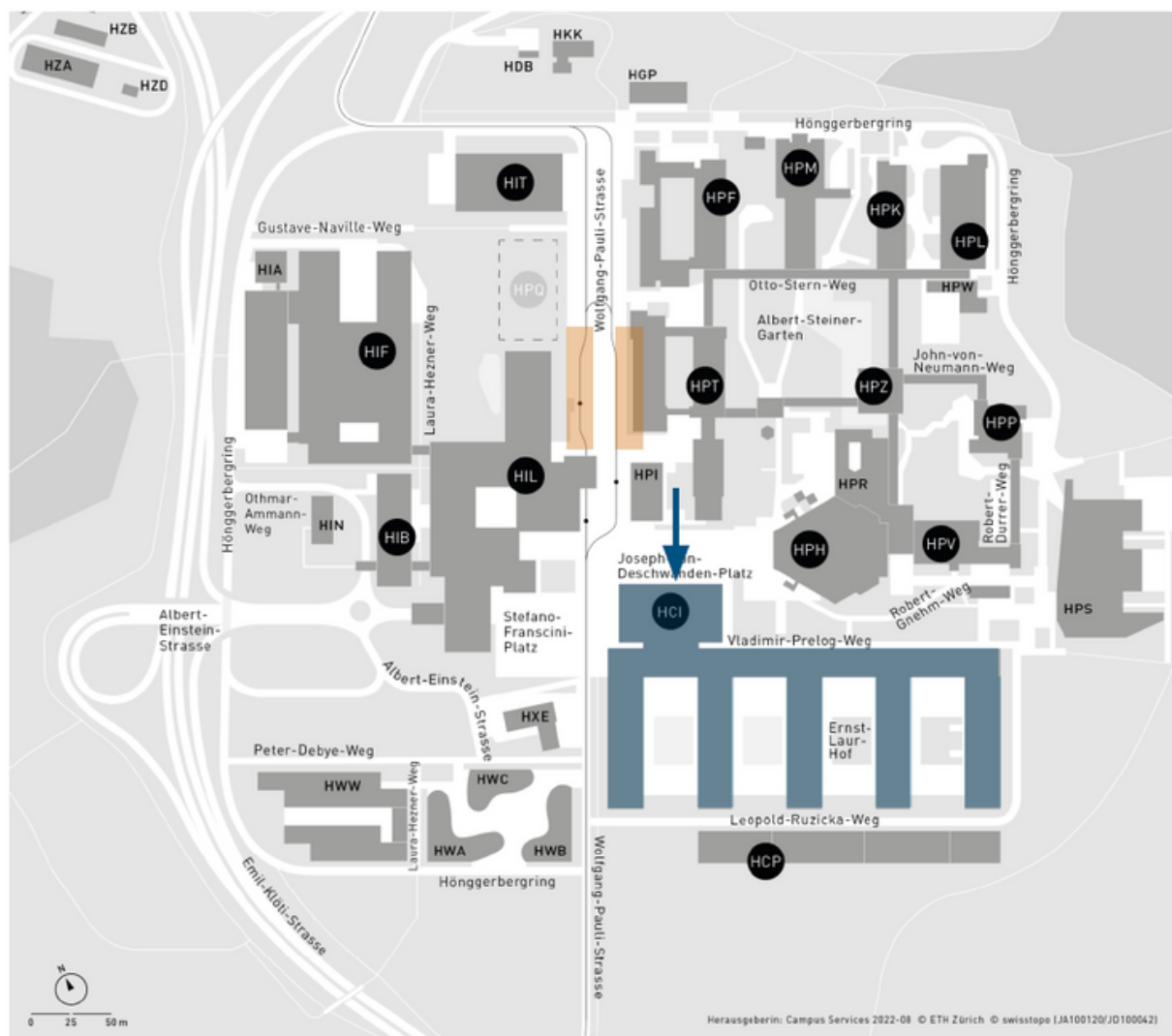## WE KINDLY THANK OUR SUPPORTERS

Platinum Sponsor

HORIBA Scientific

Gold Sponsors

25 YEARS OF EPJ.org
your physics journal

Empa
Materials Science and Technology

RENISHAW
apply innovation™

Silver Sponsors

KEYENCE

OXFORD INSTRUMENTS
WITec

STAT PEEL®
MATERIAL-SELECTIVE DETECTION SYSTEM

FLOOR PLANS

ROOMS AND CAFETERIAS

Raman Workshop

Campus Hönggerberg

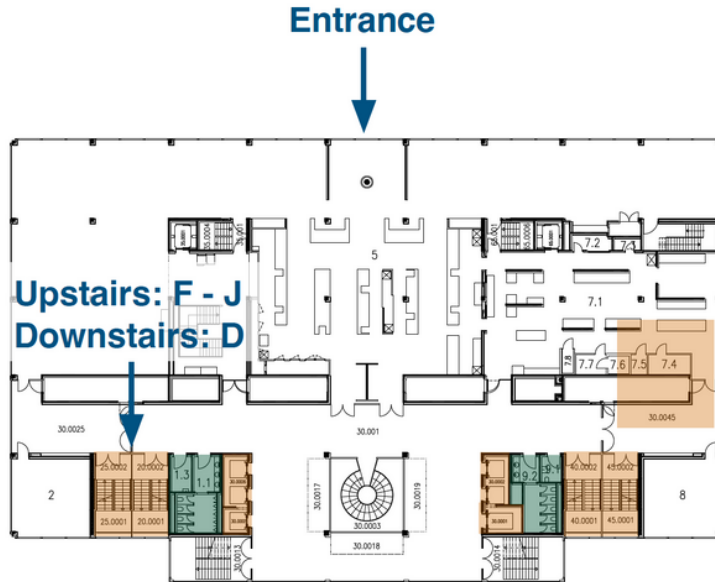|	
HCI building	**Bus stop**

ETH Zurich
Building HCI
Vladimir-Prelog-Weg 10 1
8093 Zürich
Switzerland

Bus no. 80 takes you from "Bahnhof Oerlikon Nord" directly up to "ETH Hönggerberg" (about 10 minutes) where the Raman Workshop takes place.
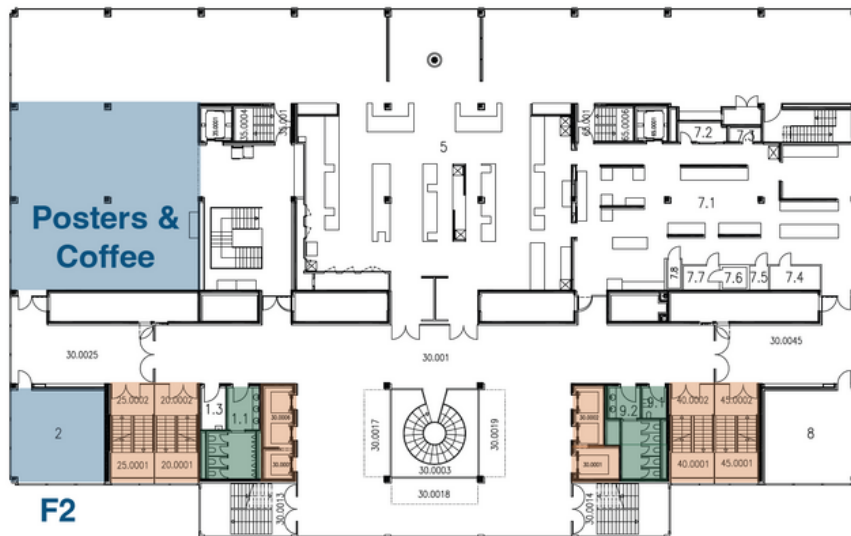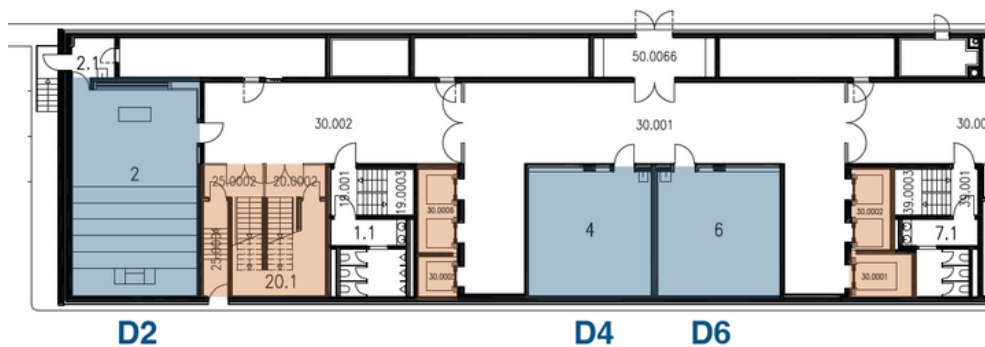
FLOOR PLANS

ROOMS AND CAFETERIAS

Raman Workshop

E-Floor (0) :

Entrance

Upstairs: F - J
Downstairs: D

F-Floor (+1):

Posters & Coffee

F2

D-Floor (-1):

Demo Sessions:
D2: Anton-Paar
D4: HORIBA
D6: Renishaw
F2: WITec

D2   **D4**   **D6**

▇ **Workshop rooms**	▇ **Stairs / Lift**	▇ **Bathrooms**

FLOOR PLANS

ROOMS AND CAFETERIAS

Raman Workshop

J-Floor (+4):
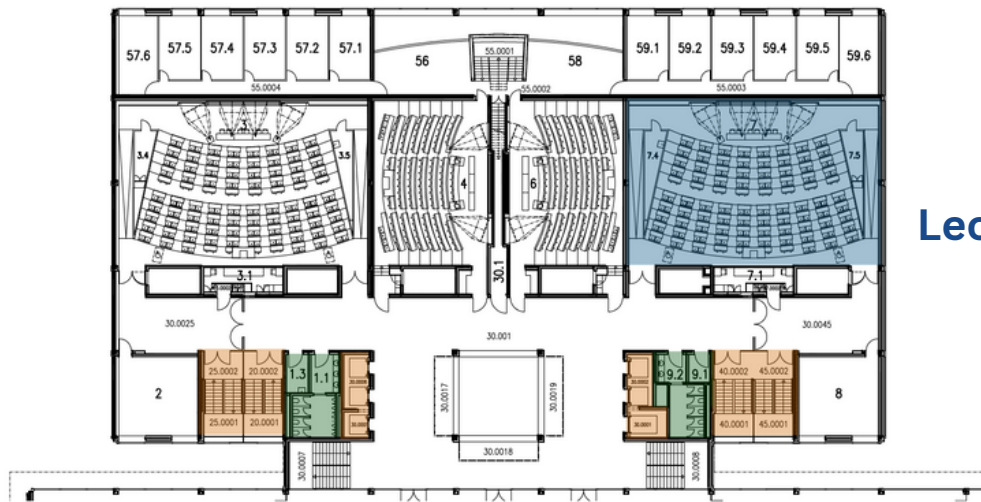
Lecture room J7

Workshop rooms   Stairs / Lift   Bathrooms

Registration	Registration desk is open in front of HCI J7 on Wednesday 9:30. Please register upon arrival and receive your name badge.
Video recording	Please do not record lectures via Foto or Video
Social events	Please join us at the Networking Apero on Thursday 5:15pm at HCI F 5
Breaks	Coffee and lunch can be enjoyed at HCI F5 (Fusion Canteen)

AGENDA

	Wednesday 07. June 2023	Thursday 08. June 2023	Friday 09. June 2023
9:00	*Raman Workshop*	**Renato Zenobi** Analytical Applications of Tip-Enhanced Raman Spectroscopy	**Naresh Kumar** Nanoscale Investigation of Surface Catalytic Processes using Tip-Enhanced Raman Spectroscopy
9:15			
9:30	**Registration**	**Katrin F. Domke** Geometric and electronic redox properties of single molecules probed with EC-TERS and plasmon-supported break-junction experiments	**Andreas Zumbusch** Non-linear Raman microscopy with electronic enhancement
9:45			
10:00			
10:15	**Opening remarks**		
10:30	**Vikas Kumar** Fundamentals of Raman spectroscopy	**Coffee break**	**Coffee break**
10:45			
11:00		**Dmitry Levshov** Raman spectroscopy of carbon-nanotube-based 1D van der Waals structures	**Pavel Matousek** Spatially Offset Raman Spectroscopy - Probing Deep inside Turbid Materials
11:15	**Thomas Bocklitz** Photonic Data Science: Data pipelines for the analysis of vibrational spectral data		
11:30			
11:45		**YIP**	**YIP**
12:00	**Lunch**	**Lunch and posters**	**Lunch and posters**
12:15			
12:30			
12:45			
13:00			
13:15			
13:30	**Mirjana Dimitrievska** Raman spectroscopy at the nanoscale: from materials to devices	**Sebastian Heeg** Surface-Sensitive Raman scattering by Transferable Nanoporous Plasmonic Membranes	
13:45			**Philipp Kukura** Making Raman spectroscopy ultrafast
14:00			
14:15	**Mauro Pasta** Characterising battery electrolytes via operando Raman microspectroscopy	**Christoph Stampfer** Raman imaging of gated graphene and twisted bilayer graphene	
14:30			**YIP**
14:45			**Carin R. Lightner** Instrumentation and Artifacts in Raman Optical Activity
15:00	**Coffee break**	**Coffee and posters**	
15:15			
15:30	**Instrument Demo**		**Concluding remarks**
15:45			
16:00		**Interactive Session**	
16:15			
16:30			**Room:** **HCI J7**
16:45			
17:00			
17:15		**Networking Apero**	
17:30			

YOUNG INVESTIGATORS

YIP

The Young Investigator Pitches will provide exciting insights into current scientific work conducted by early career researchers. The short presentations are an opportunity for up-and-coming researchers to share their perspective on Raman spectroscopy.

Thursday 11:45
Aishwarya Vishwakarma, ETH Zurich
Raman spectroscopy of epitaxial graphene: insights into layer-induced doping and defects

Friday 11:45
Fateme Yekefalah, KU Leuven & imec Belgium
Correlated TERS, TEPL, and AFM as a non-destructive technique for characterization of 2D materials

Friday 14:30
Mohammad Bagheri, University of Oulu
A large database of raman spectra created with optimized computational workflow

POSTER SESSIONS

The poster session take place in HCI F5
Thursday 12pm - 1:30pm
Thursday 3pm-3:30pm
Friday 12pm - 1:45pm

Posters presented by:
1 Seyyed Jabbar Mousavi
2 Thomas Perrault
3 Giulia Spaggiari:
4 Mads Weber
5 Zisan Celebi
6 Gaurav Kr Deshwal
7 Deniz Incesu
8 Angel Labordet Alvarez
9 Larisa Miloglyadova
10 Grazia Raciti
11 Saurabh Shukla
12 Joren van Herck

Invited Speakers

Raman Workshop

Thomas Bocklitz Leibniz-IPHT	Photonic Data Science: Data pipelines for the analysis of vibrational spectral data
Mirjana Dimitrievska EMPA	Raman spectroscopy at the nanoscale: from materials to devices
Katrin F. Domke Max-Planck-Institut für Polymerforschung	Geometric and electronic redox properties of single molecules probed with EC-TERS and plasmon-supported break-junction experiments
Sebastian Heeg Humboldt University Berlin	Surface-Sensitive Raman scattering by Transferable Nanoporous Plasmonic Membranes
Philipp Kukura University of Oxford	Making Raman spectroscopy ultrafast
Naresh Kumar ETH Zurich	Nanoscale Investigation of Surface Catalytic Processes using Tip-Enhanced Raman Spectroscopy
Vikas Kumar University of Duisburg-Essen	?Fundamentals of Raman spectroscopy
Dmitry Levshov University of Antwerp	Raman spectroscopy of carbon-nanotube-based 1D van der Waals structures
Carin Rae Lightner Enantios	Instrumentation and Artifacts in Raman Optical Activity
Pavel Matousek UKRI Science and Technologies Council	Spatially Offset Raman Spectroscopy - Probing Deep inside Turbid Materials
Mauro Pasta University of Oxford	Characterising battery electrolytes via operando Raman microspectroscopy
Christoph Stampfer RWTH Aachen University	Raman imaging of gated graphene and twisted bilayer graphene
Renato Zenobi ETH Zurich	Analytical Applications of Tip-Enhanced Raman Spectroscopy.
Andreas Zumbusch University of Konstanz	Non-linear Raman microscopy with electronic enhancement

Invited Speakers

Vikas Kumar
University of Duisburg-Essen

Principle of vibrational Raman spectroscopy, its kind, and applications

Wednesday 10:30

In this talk, we will go through basic theory of vibrational Raman spectroscopy. We will see that Raman spectrum is able to chemically identify the molecules based on their unique set of vibrational modes and serves as 'molecular fingerprints'. We will learn about spontaneous 'Stokes Raman' and 'anti-Stokes Raman' scattering, selection rules, and depolarization ratio. We will look through the concept of resonance Raman spectroscopy and surface-enhanced Raman scattering (SERS) spectroscopy, and their advantages. We will also briefly discuss the principle of nonlinear Raman spectroscopy techniques, namely coherent anti-Stokes Raman scattering (CARS) and stimulated Raman scattering (SRS), and then their advantages over spontaneous Raman spectroscopy. Along with these, we will discuss the potential applications of vibrational Raman spectroscopy.

Invited Speakers

Thomas Bocklitz
Leibniz-IPHT

Photonic Data Science: Data pipelines for the analysis of vibrational spectral data
Wednesday 11:15

Photonic techniques are more and more utilized in various disciplines such as life science and medicine. Prominent examples of these techniques are vibrational spectroscopic measurement techniques like Infrared (IR) absorption spectroscopy and Raman spectroscopy. This application increase of photonics is triggered by the improvement of the measurement techniques and their setups, but it is also driven by the development of data science methods. If data science is applied to photonic data, photonic data science is formed, which aims to extract high-level information from subtle differences in (bio-medical) photonic data. The high-level information depends on the task and the sample. Examples of these high-level information are the prediction of disease types, tissue types, and other properties of the samples like concentrations of constituents. Vibrational spectroscopic techniques such as Raman spectroscopy and IR spectroscopy feature several advantages, e.g., they can be used as non-destructive fingerprinting techniques, but to use their full potential the whole spectroscopic data life cycle needs to be studies. This includes the data generation, the data modelling, and the data archiving. Especially, the experimental design, the sample size planning, the data pre-treatment, the data pre-processing, chemometric and machine learning based data modelling, model transfer methods and transfer learning are important. All procedures are sequentially combined in a data pipeline, which standardizes the vibrational data and extracts reliable high-level information.

Herein, our recent studies with the aim to construct a standardized data analysis pipeline for bio-medical Raman spectra [1] will be presented and studies which deal with the machine leaning based modelling of spectroscopic imaging data will be described [2].

Reference(s): [1] S. Guo, J. Popp, and T. Bocklitz, "Chemometric Analysis in Raman Spectroscopy: from Experimental Design to Machine Learning based Modelling," Nature protocols, vol. 16, no. 12, pp. 5426–5459, 2021, doi: 10.1038/s41596-021-00620-3. [2] P. Pradhan et al., "Computational tissue staining of non-linear multimodal imaging using supervised and unsupervised deep learning," Biomedical Optics Express, vol. 12, no. 4, pp. 2280–2298, 2021, doi: 10.1364/BOE.415962.

Mirjana Dimitrievska

Swiss Federal Laboratories for Materials Science and Technology (EMPA)

Raman spectroscopy at the nanoscale: from materials to devices

Wednesday, 13:30

The pace at which major technological changes take place is often dictated by the rate at which new materials are discovered, and the timely arrival of new materials has always played a key role in bringing advances to our society. Machine learning and advanced simulation and modeling techniques have recently massively accelerated the fast screening and discovery of new materials. There is however today a bottleneck in the exploitation of these emerging materials. Indeed, after the materials' existence and/or properties are predicted in silico, their synthesis and integration in devices to demonstrate functionality remain major challenge. Fast and non-distractive characteriyation at the nanoscale can significantly accelerate materials optimization and bring them to the forefront of applications.

This talk will give an overview on the key role that Raman spectroscopy plays in nanoscale characterization for accelerated semiconductor materials development for optoelectronic and energy conversion applications. I will show how Raman spectroscopy could be effectively used in for probing fundamental properties of materials, such as crystal quality, phase purity, defects and phonon-carrier interactions. This will follow with presenting Raman-based methodologies for nanoscale detection of impurities in materials, leading to establishing accurate phase diagrams and predictive synthesis-structure-property relationships. Finally I will discuss Raman-based mapping of the defect structure/space of thin film solar cells to optimize device structure.

Invited Speakers

Raman Workshop

Mauro Pasta

University of Oxford
Professor of Applied Electrochemistry

Characterising battery electrolytes via operando Raman microspectroscopy

Wednesday 14:15

Understanding the transport and thermodynamic properties of electrolytes is crucial for the development of Li-ion and beyond Li-ion battery technologies. In my talk, I will introduce a comprehensive method for characterizing electrolyte systems. Our approach involves measuring the electrolyte concentration gradient over time using operando Raman microspectroscopy, along with potentiostatic electrochemical impedance spectroscopy. Through this method, we can determine several important electrolyte properties, including the Fickian diffusion coefficient, transference number, thermodynamic factor, ionic conductivity, and resistance of charge-transfer, all in a single experimental setup. Our study also offers a way to visualize the electrolyte concentration gradient and to correlate bulk intermolecular electrolyte structure with transport and thermodynamic properties.

Invited Speakers

Raman Workshop

Renato Zenobi
ETH Zurich

Analytical Applications of Tip-enhanced Raman Spectroscopy
Thursday 9:00

Tip-enhanced Raman Spectroscopy (TERS) is a nanoscale chemical analysis and imaging method with a spatial resolution of <10 nm, even at ambient conditions that relies on the enhancement of the local electromagnetic field by a plasmonic metal nanostructure that is scanned over the sample by means of a scanning probe microscope, using either AFM or STM feedback.
After a very brief introduction of the TERS working principle and capabilities, several practical aspects will be discussed, including interpretation (and misinterpretation) of TERS spectra due to issues such as tip contamination and sample decomposition triggered by the very high local field under the TERS tip. The focus will be on strategies to mitigate sample decomposition, for imaging studies of fragile samples over extended periods of time, and ways to improve the reproducibility of TERS, especially for investigation of biological samples.
In the second, main part of this presentation, applications of TERS to the spatially resolved chemical analysis and imaging of surfaces and molecular nanomaterials will be discussed. Examples from recent TERS studies in our laboratory will be presented, including two-dimensional polymers (2DPs), biological nanostructures such as model membranes, polymer surfaces, and catalysts.

Invited Speakers

Katrin F. Domke

Max-Planck-Institut für Polymerforschung

Geometric and electronic redox properties of single molecules probed with EC-TERS and plasmon-supported break-junction experiments

Thursday 9:45

Gathering information about the geometric and electronic redox properties of individual molecules is highly desirable to advance and tailor to desire molecular electronics devices, or (physiological) electron transfer systems in general. In my talk, I will highlight our recent methodological advances with STM-based operando nearfield Raman spectroscopy and plasmon-supported break-junction experiments. These approaches allow us to gain correlated chemical, topographic and electronic molecular-level information about, for example, adsorption geometry, chemical interaction and conversion and molecular conductance with extreme spatial resolution under reaction conditions.

Invited Speakers

Dmitry Levshov
University of Antwerp

**Raman spectroscopy of carbon nanotube
-based 1D van der Waals structures**
Thursday 11:00

 1D van der Waals (vdW) structures are an emerging class of nanomaterials composed of coaxially-stacked nanotubes coupled by vdW forces [1]. Each of these nanotubes exhibits remarkable physical properties, with some being metals, semiconductors, or insulators. Combining them into a single structure not only leads to a vast number of potential applications, but also results in novel physical phenomena arising from interlayer vdW coupling and quantum confinement [2].
 In this talk, I will discuss recent advancements in the structural characterization of 1D vdW structures based on carbon nanotubes, using resonant Raman spectroscopy. To provide a clear illustration, I will focus on the simplest and the most well-studied 1D vdW structure, the double-walled carbon nanotube (DWCNT). I will demonstrate how the analysis of Raman active modes of DWCNTs enables accurate estimation of their diameters, inter-layer distances and roll-up angles. Additionally, I will report our recent findings concerning the investigation of moiré-induced vibrational coupling, intertube optical transitions, and electronic Raman scattering.
 Lastly, I will explore the practical application of these findings in characterizing more complex types of 1D vdW structures and offer insights into future developments, particularly emphasizing the role of Raman optical activity.

[1] Cambré et al. Small, 17(38), 2102585, 2021
[2] Zhao et al. Advanced Science, 9(2), 2103460, 2022

Invited Speakers

Sebastian Heeg
Humboldt University Berlin

Surface-Sensitive Raman Scattering by Transferable Nanoporous Plasmonic Membranes
Thursday 1:30pm

Raman spectroscopy is a powerful technique to characterize materials. It probes non-destructively chemical composition, crystallinity, defects, strain and coupling phenomena. However, the Raman response of surfaces or thin films is often weak and obscured by dominant bulk signals. I this talk, I will show how we overcome this limitation by placing a transferable porous gold membrane (PAuM) on top of the surface of interest. Slot-like nanopores in the membrane act as plasmonic slot antennas and enhance the Raman response of the surface or thin film underneath. Simultaneously, the PAuM suppresses the penetration of the excitation laser into the bulk, efficiently blocking the bulk Raman signal. Using graphene as a model surface, we show that these two simultaneous effects lead to an increase in the surface-to-bulk Raman signal ratio by three orders of magnitude. We find that 90% of the Raman enhancement occurs within the top 2.5 of the material, demonstrating truly surface-sensitive Raman scattering. To validate our approach, we analyze the surface of a $LaNiO3$ thin film. We observe a Raman mode splitting for the $LaNiO3$ surface-layer, which is spectroscopic evidence that the surface structure differs from the bulk. Finally, I will discuss future routes of surface-sensitive Raman spectroscopy.

Invited Speakers

Christoph Stampfer
RWTH Aachen University

Raman imaging of gated graphene and twisted bilayer graphene
Thursday 14:15

Raman spectroscopy – the use of inelastic light scattering as a probe – has become one of the workhorses of materials characterization. It is fast, simple, and non-destructive, yet it yields insights into both the electronic and vibrational (phonon) properties of a material as well as into their interplay, such as the electron-phonon interaction. Extracting insights of the detailed material properties on an atomistic, "fundamental" level from its measured Raman spectrum, however, is still subject of ongoing research. In this talk, I will give an overview of our experimental efforts to extract insights into material properties from Raman spectroscopy. I will present low-temperature Raman measurements on gate-tunable graphene encapsulated in hexagonal boron nitride, which allows us to study in detail the Raman G and 2D mode frequencies and linewidths as a function of the charge carrier density. This study not only provide insights into electron-phonon coupling and the role of electron-electron scattering in the peak broadening, but also crucially show the limitations when it comes to the use of Raman spectroscopy to benchmark graphene in terms of charge carrier density, strain, and strain inhomogeneities. This is particularly relevant when utilizing spatially resolved 2D Raman linewidth maps to assess substrate-induced nanometer-scale strain variations.
In the second part of the talk I will highlight that confocal Raman spectroscopy can be utilized to spatially map the twist angle in stacked bilayer graphene for angles between 6.5∘ and 8∘. The twist angles can directly be extracted from the moiré superlattice-activated Raman scattering process of the transverse acoustic (TA) phonon mode. I show that the width of the TA Raman peak contains valuable information on spatial twist angle variations on length scales below the laser spot size of ~500 nm.

Invited Speakers

Naresh Kumar
ETH Zurich

Nanoscale Investigation of Surface Catalytic Processes using Tip-Enhanced Raman Spectroscopy
Friday 9:00

During the last two decades, Tip-Enhanced Raman Spectroscopy (TERS) has emerged as a powerful analytical tool for studying surface chemistry with nanoscale spatial resolution [1-3]. In this talk, I will cover several key aspects of the application of TERS in studying heterogenous catalytic reactions. In the first part, I will discuss the application of TERS to study plasmon-driven photocatalytic reactions. I will highlight the ability of TERS to map catalytic activity at the nanoscale, providing insights into the spatial distribution photocatalytic reaction hotspots on a nanostructured Ag surface [4]. Then, I will discuss the exploration of photocatalytic processes in liquid phase using TERS, showcasing the capability of TERS to observe dynamic changes during heterogenous catalytic reactions [5]. Finally, I will delve into the investigation of reactive arrangement in on-surface photocatalytic coupling reactions using TERS [6]. By combining TERS with molecular-level insights, we can gain a deeper understanding of the role of reactive arrangement in the efficiency of these reactions.
In the second part of the talk, I will discuss the use of a different but related technique called Tip-Enhanced Fluorescence (TEFL) imaging for nanoscale chemical imaging of zeolite acidity in fluid cracking catalyst particles [7] and the characterization of coke formation on ZSM-5 zeolite catalysts during methanol-to-hydrocarbon reaction [8]. These studies demonstrate the unique capabilities of hyperspectral TEFL imaging in providing spatial and chemical information at the nanoscale.
Overall, this talk will highlight the significant contributions and potential of Tip-enhanced Optical Spectroscopy (TEOS) in the nanoscale investigation of surface catalytic processes. By elucidating the spatial distribution, dynamics, and reactive arrangement of catalytic reactions, TEOS offers valuable insights for advancing our understanding of surface chemistry and guiding the development of efficient catalysts.

Invited Speakers

Andreas Zumbusch
University of Konstanz
Professor of Physical Chemistry

Non-linear Raman microscopy with electronic enhancement

Friday 9:45

Label-free imaging techniques have recently met a lot of interest as a complement to fluorescence based imaging approaches. While imaging modalities such as second harmonic generation (SHG) and third harmonic generation (THG) microscopy allow contrast generation based on symmetry breaks in the samples, especially non-linear Raman microscopy has been pursued by many groups worldwide. The special advantage of these techniques is the possibility to generate contrast without the need for sample labelling. Instead, molecule specific contrast is generated based on the vibrational spectra of sample molecules. The two main approaches of this type are coherent anti-Stokes Raman scattering (CARS) microscopy and stimulated Raman scattering (SRS) microscopy. While the basic mechanism behind the two techniques is the same, the experimental setups required differ significantly, mainly with respect to the detection scheme. In this contribution, I will give an overview of the state of the art for the different nonlinear Raman microscopy techniques. Different experimental approaches will be shown and their virtues will be demonstrated with examples from cell biology, material science, and biomedicine. Special emphasis will be put on the discussion of recent efforts to increase the sensitivity of non-linear Raman microscopy techniques by exploiting electronic resonances. I will demonstrate that using this approach, the detection of vibrational spectra of single molecules is within reach.

Invited Speakers

Pavel Matousek
UKRI Science and Technologies Council

Spatially Offset Raman Spectroscopy - Probing Deep inside Turbid Materials
Friday 11:00

The non-invasive compositional analysis of diffusely scattering (turbid) samples such as powders, opaque bottles or biological tissues, at depth is a fast evolving area of Raman spectroscopy spurred by the recent advent of Spatially Offset Raman Spectroscopy (SORS). Accessible depths with SORS can be more than an order of magnitude larger than those attainable with conventional Raman spectroscopy enabling, for example, non-invasive interrogation several mm's, and in some cases several cm's, deep inside biological tissues. This presentation will focus on the development of SORS, its basic principles and discuss new application areas it is opening, including the detection of explosives in airport security, quality control of pharmaceutical products, subsurface analysis of objects of art and non-invasive cancer and bone disease diagnoses.

Invited Speakers

Philipp Kukura
University of Oxford

Making Raman spectroscopy ultrafast

Friday 13:45

One of the unique properties of molecular vibrations is its extreme sensitivity to molecular structure. Miniscule changes to bond lengths and angles, or the slightest changes in interaction with the molecular environment can have a dramatic effect on the associated vibrational frequencies, making vibrational spectroscopy extremely sensitive to molecular structure. Recording vibrational spectra as a function of time thus offers the prospect of following structural dynamics with high structural sensitivity and time-resolution, given sufficient sensitivity and optical pulses of appropriate duration using traditional pump-probe approaches.

A key challenge herein is the fact that the structural sensitivity, which largely stems from being able to measure vibrational frequencies with high accuracy, is at odds with achieving high-temporal resolution, which leads to energy broadening through the time-energy uncertainty relation. This difficulty is exacerbated when attempting to reach the ultimate goal of monitoring molecular dynamics in real time, given that molecular vibrations define the respective time scales of molecular vibrations in the first place.

I will discuss efforts in ultrafast vibrational spectroscopy with a focus on Raman scattering over the past 20 years aimed at reaching the very limits in terms of obtaining structural information from vibrational spectra with femtosecond temporal resolution. Beginning with femtosecond stimulated Raman spectroscopy (FSRS), I will illustrate how structural information beyond the traditional time-energy uncertainty limits can be obtained, under the assumption that the underlying signal generation process is well-understood. This improvement in temporal resolution is analogous to, for example, improvements in the resolution of optical microscopes through single molecule localisation. I will conclude by demonstrating the (dis)advantages of translating the same measurement into the time-domain, in the form of impulsive vibrational spectroscopy (IVS).

Invited Speakers

Carin Lightner
Enantios

Instrumentation and artifacts in Raman optical activity

Friday 14:30

Raman optical activity (ROA) is a powerful chiroptical technique with the ability to determine absolute configuration of chiral molecules and to study protein structure in biologically relevant solvents. Despite its promise, experimental ROA studies are still much less common than studies with vibrational circular dichroism (VCD), a closely related technique. Much of this difference relates to the greater complexity of ROA instruments, and the problem of artifacts in ROA. ROA measurements require careful control of both the incident and scattered polarization states, as well as needing spatial rather than point detection systems to resolve the full spectrum. The standard of modern ROA instruments was set by Werner Hug in 1991, and the impact of artifacts was further reduced by Hug's development of the virtual enantiomer system in 2002. (1,2) Despite these advances, the complexity of ROA instrumentation and the problem of artifacts still prevents ROA from widespread use. We have constructed a new ROA instrument based on high-frequency polarization modulation. (3) Additionally, we have developed an expanded method of understanding and identifying artifacts in ROA measurements. Together these advances push ROA instrumentation closer to the more widely used domain of CD and VCD instruments.

References:
1.Hug W., Hangartner G., Journal of Raman Spectroscopy 30 (1991) 841-852
2.Hug, W. Appl Spectrosc 2002, 57 (1), 1–13.
3.Lightner, C. R.; Gisler, D.; Meyer, S. A.; Niese, H.; Keitel, R. C.; Norris, D. J. ,J Phys Chem 2021, 125 (36), 8132–8139.

Organizational Comitee

Miroslav Haluska
D-MAVT

Katharina A. Trapp
D-MAVT

Morten Vollmann
D-MAVT

Xiaoyu Zhao
D-HEST

Sung Sik Lee
ScopeM

Siiri Bienz
D-CHAB

Christopher Dreimol
D-BAUG

Barbara Lau
Map

Advisory Board

Renato Zenobi
D-CHAB

Ingo Burgert
D-BAUG

Miroslav Haluska
D-MAVT

David Norris
D-MAVT

Klara Berg
MaP Executive Director

Attendees

Alinezhadfar	Mohammad	mohammad.alinezhadfar@empa.ch, malinezhadfa@ethz.ch
Altun	Ali Ozhan	altun@unisers.ch
Baer	Josephine	jbaer@ethz.ch
BAGCHI	SASWATI	saswati.bagchi@studenti.unipg.it
Bagheri	Mohammad	mohammad.bagheri@oulu.fi
Bartolewska	Magdalena	mbartol@ippt.pan.pl
Basuri	Pallab	pallab.basuri@phys.chem.ethz.ch
Belanche Guadas	Manuel	belanche@aps.ee.ethz.ch
Belyaeva	Liubov	lbelyaeva@chem.ethz.com
Berg	Klara	klara.berg@mat.ethz.ch
Bernero	Margherita	bernerom@ethz.ch
Bienz	Siiri	bienz@org.chem.ethz.ch
BISWAS	DEBMALYA	debmalya.biswas001@gmail.com
Busch	Christoph	buschc@ethz.ch
Buxeda	Alex	alexbuxeda@gmail.com
Camesasca	Paolo	paolo.camesaca@ifb.baug.ethz.ch
CELEBI	ZISAN	zisancelebii@gmail.com
Chan	Ivy	ivychanmedic@gmail.com
Chutani	Doll	doll.chutani@wur.nl
Clavijo Arcos	Rolando Esteban	r.clavijo@erdw.ETHZ.ch
Cocen	Ocson Reginald	ocson.cocen@he-arc.ch
Cocina	Ario	ario.cocina@unisers.ch
Davra	Akshay	davra.21bsmb01@student.nitte.edu.in
De Alwis	Nethmi	Wdealwis@ethz.ch
Deshwal	Gaurav Kr	gaurav.deshwal@wur.nl
Dimitrievska	Mirjana	mirjana.dimitrievska@empa.ch
Dosnon	Lucas	Ldosnon@student.ethz.ch
Dr. Borosy	Andras	borosy@bluewin.ch
Dreimol	Christopher	cdreimol@ethz.ch
El Abbassi	Maria	maria@chiralnano.com
Francaviglia	Luca	lfrancavigli@ethz.ch
Gao	Min	mingao@student.ethz.ch
Gehre	Christian	cgehre@ethz.ch
goetz	marlon	magoetz@ethz.ch
Gomez Marin	Ana Maria	gomeza@mpip-mainz.mpg.de
Gomez-Marim	Ana Maria	agomezma@ita.br
Goncalves de Medeiros	Helton	medeiros@aps.ee.ethz.ch
Granget	Elodie	elodie.granget@he-arc.ch
Gulcin	Ezgi	ezgigulcin96@gmail.com

Attendees

Haluska	Miroslav	haluskam@ethz.ch
Han	Yu	yuhanyu@ethz.ch
Haug	Muriel	haugm@ethz.ch
Helkkula	Pyry	pyry.helkkula@helsinki.fi
Henshaw	Richard	rhenshaw@ethz.ch
Hong	Nathan	chhong@ethz.ch
HORRER	Marion	marion.horrer@hest.ethz.ch
Hwang	Jeong Ha	jeongha.hwang@empa.ch
Incesu	Deniz	denizzincesu@gmail.com
Isa	Lucio	lucio.isa@mat.ethz.ch
Ivan	Zivadinovic	izivadinovic@student.ethz.ch
Iwakiri	Shuichi	siwakiri@phys.ethz.ch
Jantarug	Krittapas	krittapas.jantarug@uzh.ch
Jin	Xiaoyu	xiajin@student.ethz.ch
Jung	Se-Hyeong	se-hyeong.jung@mat.ethz.ch
Kanjampurath Sivan	Aswathi	aswathi.kanjampurathsivan@unibas.ch
Kindler	Robert	rkindler@ethz.ch
Kong	Ying	kongying916@gmail.com
Kuleshova	Iuliia	julia_kul2000@mail.ru
Kulshrestha	Romir	romir.kulshrestha@gmail.com
Kumaar	Dhananjey	dvenkate@ethz.ch
Kürsteiner	Ronny	ronnyk@ethz.ch
Kusetic	Filip	fkusetic@student.ethz.ch
Labordet Alvarez	Angel Victor	avla2@kth.se
Labordet Álvarez	Ángel	angel.labordet@empa.ch
Lau	Barbarbara	barbara.lau@mat.ethz.ch
Lauria	Alessandro	alessandro.lauria@mat.ethz.ch
Lee	Sung Sik	leesu@ethz.ch
Lee	Kang Soo	leeka@ethz.ch
Lissandrello	Federico	flissandrell@ethz.ch
Liu	Yang	yangliu1@ethz.ch
Liu	Poting	poting.liu@leibniz-ipht.de
Marzini	Lorenzo	marzini4@student.unisi.it
Mehrabi	Kamyar	KAMYARMEHRABI@GMAIL.COM
Michael	Seitz	ms@spiden.com
Miloglyadova	Larisa	larisa.miloglyadova@org.chem.ethz.ch
Mintrone	Michael	michael.mintrone@ssef.ch
Mousavi	Seyyed Jabbar	jabbar.mousavi@chem.uzh.ch
Ng	Joo Siang	jsn@phenosign.com
Niese	Hannah	nieseh@ethz.ch

Attendees

Ocana-Pujol	Jose L.	joseo@ethz.ch
Pan	Yanlin	panyan@student.ethz.ch
Perrault	Thomas	thomas.perrault@univ-lemans.fr
Pinotsi	Dorothea	dpinotsi@ethz.ch
Pramoj Na Ayutthaya	Pratchaya	ppramoj@ethz.ch
Prettenthaler	Jakob	jprettent@student.ethz.ch
Pustovalov	Vitaly	vpustovalov@student.ethz.ch
Qin	Xiao-Hua	qinx@ethz.ch
Raciti	Grazia	grazia.raciti@unibas.ch
Radaelli	Eleonora Giulia	eradaelli@ethz.ch
Ritter	Maximilian	maxritter@student.ethz.ch
Rusanov	Eduard	erusanov@ethz.ch
SADHUKHAN	DHRUBAJYOTI	dhrubajyoti.sadhukhan@mail.polimi.it
SARKAR	SANSKRITI	sanskritisarkar50@gmail.com
Schreiner	Sonja	sschreiner@ethz.ch
Shapiro	Arthur	shapiroa@ethz.ch
SHUKLA	SAMIKSHA	SAMIKSHA.MSC@GMAIL.COM
Shukla	Saurabh	saurabh.shukla@chem.uzh.ch
Sk	Amanullah	amansk@ethz.ch
Spaggiari	Giulia	Giulia.spaggiari1@unipr.it
Synhaivska	Olena	os@spiden.com
Thakur	Pritesh	priteshthakur402@gmail.com
Tinello	Susanna	susanna.tinello@mat.ethz.ch
Trapp	Katharina	katharina.trapp@echemes.ethz.ch
Trautvetter	Johannes	johannes.trautvetter@unibas.ch
Trespi	Silvio	strespi@ethz.ch
Vahedi Kia	Nooshin	nooshin.vahedikia@teagasc.ie
Van Herck	Joren	joren.vanherck@epfl.ch
Vidaurre	Renzo	renzovidaurre99@gmail.com
Vishwakarma	Aishwarya	aishwarya.vishwakarma@mat.ethz.ch
Vollmann	Morten	mvollmann@ethz.ch
Wagle	Sampada	sampadaaawagle2127@gmail.com
Wang	Xiaoxian	xiaoxwang@ethz.ch
Weber	Mads	Mads.Weber@univ-lemans.fr
Wettstein	Lionel	lwettstein@ethz.ch
Yadong	Li	taralll103663@gmail.com
Yekefalah	Fateme	yekefa24@imec.be
Zauchner	Doris	doris.zauchner@hest.ethz.ch
Zayed	Gamal	gamal.zayed@aucegypt.edu
Zhao	Xiaoyu	xiaoyu.zhao@hest.ethz.ch