Birck Annual Research Symposium

April 28, 2025

8 am – 9 am	**Breakfast**	MRGN cafe
9 am - 9:10 am	Opening Remarks by **Mark Lundstrom** Don and Carol Scifres Distinguished Professor of Electrical and Computer Engineering	MRGN 121
9:10 am – 9:30 am	"Looking Ahead to Birck's Next 20 Years": **Zhihong Chen** Reilly Professor of Electrical and Computer Engineering; Mary Jo and Robert L. Kirk, Director, Birck Nanotechnology Center	"
	INVITED TALKS, MORNING SESSION	"
9:30 am – 10:05 am	"An Ode to Birck: Enabling Research, Inspiring Innovation", **Muhammad Alam** Jai N. Gupta Professor of Electrical and Computer Engineering	"
10:05 am – 10:40 am	"Integrated Quantum Photonics on Silicon Platform", **Vladimir Shalaev** The Robert and Anne Burnett Distinguished Professor of Electrical and Computer Engineering	"
10:40 am – 11:15 am	"Building a 200mm Equipment Line Platform for Semiconductor Packaging Prototyping and System Integration", **Tiwei Wei** Assistant Professor of Mechanical Engineering	"
11:15 am – 11:50 am	"The imec-Purdue collaboration and the role of R&D in semiconductors", **Francesca Iacopi** imec Fellow, Director of imec's Semiconductor R&D Site at Purdue	"
11:50 am – 12:45 pm	**Lunch**	MRGN cafe
	INVITED TALKS, AFTERNOON SESSION	MRGN 121
12:45 pm – 1:15 pm	"HADAR: Why AI will revolutionize thermal night vision", **Zubin Jacob** Elmore Professor of Electrical and Computer Engineering	"
1:15 pm – 1:45 pm	"Non-reciprocal Transport Phenomena in Solids", **Yuli Lyanda-Geller** Professor of Physics and Astronomy	"
1:45 pm – 2:15 pm	"Electron and nuclear spin qubits in 2D materials", **Tongcang Li** Professor of Physics and Astronomy, Professor of Electrical and Computer Engineering	"
2:15 pm – 2:20 pm	**Break**	
2:20 pm – 2:50 pm	"Perspectives of Quantum Computing in Chemical Engineering", **David E. Bernal** Assistant Professor of Chemical Engineering	"
2:50 pm – 3:20 pm	"Probing exotic electronic states in transition metal dichalcogenides with scanning tunneling microscopy", **Tiancong Zhu** Assistant Professor of Physics and Astronomy	"
3:20 pm – 3:50 pm	"Photonic-integrated manufacturing and testing for defense and commercial applications", **Peter Bermel** Elmore Professor of Electrical and Computer Engineering	"
4:00 pm – 4:30 pm	**Birck Open House**	BRK
4:30 – 6:30 pm	**POSTER SESSION** with hors d'oeuvres	BRK atrium BRK 1001

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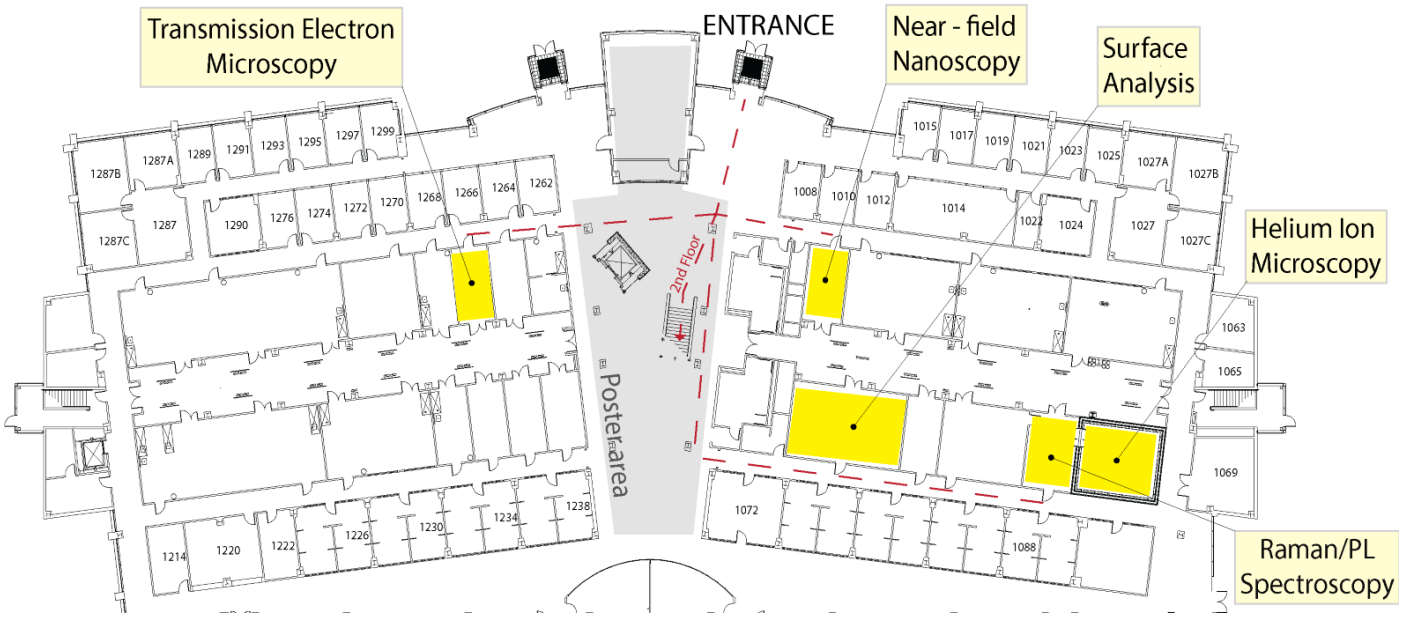
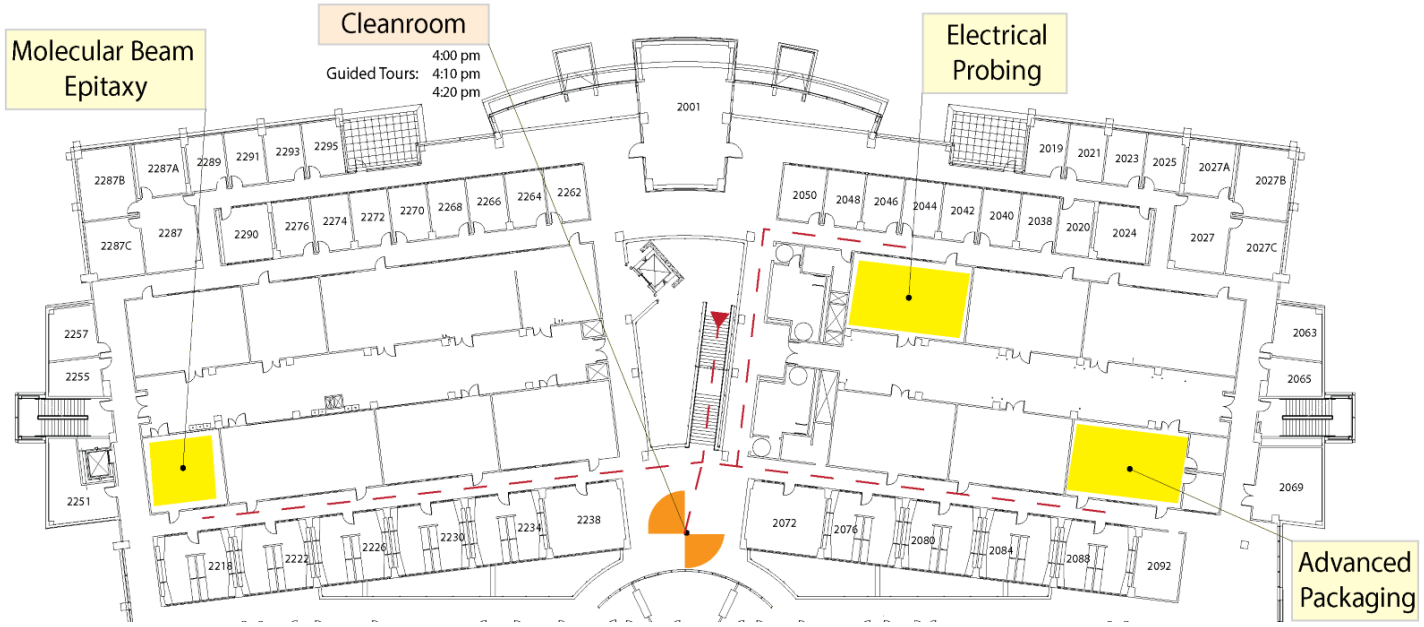
Birck Open House: 4:00 pm – 4:30 pm



FIRST FLOOR



SECOND FLOOR

Guided tours around Cleanroom will be starting at 4:00 / 4:10 / 4:20 pm

– – – – = Walking path to open labs.

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Overviews of Birck Open House featured labs

Please note: No food is allowed in the labs.

Scifres Nanofabrication Cleanroom — Top of atrium stairs

One of the largest and cleanest university cleanrooms in the world, the nanofabrication cleanroom consists of 25,000 square feet of bay-chase cleanroom, with 20% of the bays operating at ISO 3 (Class 1), 50% operating at ISO 4 (Class 10), 15% operating at ISO 5 (Class 100), and the remaining 15% operating at ISO 6 (Class 1000). The Scifres cleanroom has a complete semiconductor processing capability in patterning (laser, optical and e-beam lithography), wet and plasma etching, deposition (CVD, PECVD, ALD, PVD), and thermal (oxidations, anneals, polysilicon, LTO, LP nitride, and TEOS).

Transmission Electron Microscopy — Room #: 1269

The double aberration corrected Themis (S)TEM can reach sub-angstrom spatial resolution and 100 meV energy resolution for atomic imaging and analytical study. Low voltages and integrated differential phase contrast technique are available for beam sensitive materials.

Advanced Packaging — Room #: 2087

Our group develops a variety of advanced materials, including semiconductor interconnects such as through-silicon vias (TSVs), through-glass vias (TGVs), micro-bumps, and thermal interface materials (TIMs). At the Advanced Packaging Laboratory, we conduct copper growth experiments using electrochemical plating, followed by post-processing steps such as chemical–mechanical polishing (CMP) and bonding using a flip-chip bonder.

Electrical Probing — Room #: 2043

A suite of probe stations provides independent micromanipulated electrical probing of devices and device arrays from DC to RF (40 GHz) frequencies, with semi-automated probing up to 8” wafer size. Environments include air, inert gas, and ultra-high vacuum at temperatures from 4.5 K up to 900 C and with out-of-plane magnetic fields up to 2.5 tesla. Recent additions to measurement electronics include parameter analyzers with combined high resolution I-V and multi-frequency C-V; state-of-the-art advanced low frequency noise analyzer (A-LFNA); arbitrary waveform generator and real time oscilloscope up to 13 GHz; vector network analyzer to 44 GHz; high current/voltage device testing; and phase noise, noise figure and advanced network analysis up to mm wave (300 GHz).

Molecular Beam Epitaxy (MBE) — Room #: 2217

The Quantum Semiconductor Systems Group focuses on the quantum-mechanical properties of electrons in ultra-high purity III-V semiconductor and superconductor devices. To build nanostructures needed for our experiments, we use a high-purity growth technique known as molecular beam epitaxy (MBE). MBE allows us to build semiconductor structures one atomic layer at a time and thus engineer the electronic energy levels to suit our needs. We can build a two-dimensional electron gas (2DEG) in which the mean free path exceeds 0.35mm at low temperatures.

Helium Ion Microscopy/Nanofabrication — Room #: 1089A

Zeiss ORION NanoFab is a revolutionary helium ion microscope (HIM) that takes nanoscale imaging and nanofabrication to new heights. This tool offers innovative capabilities for imaging and nanofabrication using high-brightness, highly focused ion beams (He^+ or Ne^+) generated from a single atomic source.

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Near-field Optical and Thermal Nanoscopy

Room #: 1045

The Near-Field Lab houses a nanoscopy instrument capable of performing nano-FTIR, nano-Raman/PL, and ultrafast spectroscopy with nanoscale spatial resolution, utilizing an Atomic Force Microscopy (AFM)-based technique. Additionally, a narrow-linewidth optical parametric oscillator (OPO) laser enables nano-IR imaging across a broad wavelength range. This recently developed nanoscopy technique allows for detailed nanoscale characterization of a wide variety of materials, including 2D materials, emerging energy materials, inorganic compounds, and photonic structures.

Raman/PL Spectroscopy (Specere Lab)

Room #: 1089

Specere Lab is currently involved in a variety of semiconductor related projects including characterizing next-gen TMD materials for transistors, stress in through silicon vias, oxygen vacancies in Ferroelectric HZO for memory devices and high resolution heat measurement techniques with Raman. The primary system used for this work is WITec's alpha300 R optical system capable of diffraction limited Raman and photoluminescence spectroscopy. A Specere designed electrical probing stage integrated into the system provides allows 2D opto-electrical maps where light is used in conjunction with electrical equipment to measure electron-photon interactions in sub-micron devices. Light coupled into the system consists of a Xenon lamp and monochrometer selecting a single wavelength between 250nm and 1000nm along with four visible light lasers that couple into the optical system.

Surface Analysis

Room #: 1077

In the development of nanomaterial electronics and quantum materials, understanding and controlling surface properties are crucial. we use techniques of X-ray Photoelectron Spectroscopy (XPS), Low Energy Electron Diffraction (LEED), Scanning Tunneling Microscopy (STM), High-Resolution Electron Energy Loss Spectroscopy (HREELS). They delve into the atomic and molecular structure of surfaces, offering vital insights into nanomaterial composition, morphology, and electronic properties. XPS enables precise elemental and chemical analysis, STM provides atomic-scale imaging for tailoring electronic behaviors, LEED aids in surface crystallography, HREELS reveals surface vibrational information.