
NANOFABRICATION SEMINAR: Ion Beam Lithography for Nanophotonics

MARIO HENTSCHEL

September 30, 2026

12:00 to 13:00

Elements Room

ABSTRACT:

Nanophotonics has evolved into a remarkably diverse field, with applications ranging from optical metasurfaces and integrated photonics to quantum technologies and environmental sensing. As the complexity of photonic architectures continues to grow, so do the demands on nanofabrication. While established lithographic approaches provide excellent throughput for mature designs, they often lack the flexibility required for rapid prototyping, iterative optimization, and the exploration of unconventional materials and substrates.

Ion beam lithography has emerged as a uniquely versatile direct-write fabrication platform that complements conventional cleanroom processes. By enabling maskless patterning with nanometer precision, it provides rapid design iteration, direct access to virtually any material system, and an intrinsic grayscale capability that allows continuous three-dimensional surface profiling in a single fabrication step. Together, these characteristics enable photonic structures that are difficult or impossible to realize using conventional lithographic workflows and open new opportunities for both fundamental research and application-driven device development.

This seminar will discuss the capabilities, advantages, and practical limitations of ion beam lithography for nanophotonic research. Through a series of examples, I will demonstrate how ion beam milling enables the realization of plasmonic and dielectric nanostructures, optical metasurfaces, Mie void resonators, electron-driven photon sources, and complex micro- and nanostructured preforms for injection-compression molding. I will also discuss hybrid fabrication strategies that combine ion beam and electron-beam lithography to exploit the strengths of both approaches. Finally, I will highlight recent developments, current challenges, and future opportunities for focused ion beam nanofabrication as an enabling technology for next-generation photonic devices.

BIOGRAPHY:

Dr. Mario Hentschel is a researcher in nanophotonics at the University of Stuttgart, where he leads nanofabrication activities at the 4th Physics Institute and the Center for Integrated Quantum Science and Technology (IQST). He studied physics at the University of Bonn and received his Ph.D. from the University of Stuttgart in 2013 under the supervision of Prof. Harald Giessen, working on complex plasmonic nanostructures, optical chirality, Fano

resonances, and nonlinear optics. As an Alexander von Humboldt Feodor Lynen Fellow, he subsequently conducted research with Prof. A. Paul Alivisatos and Prof. Gabor A. Somorjai at the University of California, Berkeley, and Lawrence Berkeley National Laboratory, where he worked on bottom-up DNA-directed self-assembly of plasmonic nanostructures.

His research combines nanophotonics with advanced micro- and nanofabrication, spanning ion beam lithography, plasmonics, dielectric nanophotonics, nonlinear optics, optical chirality, environmental nanophotonics, and nanoscale spectroscopy. His current interests include rapid prototyping of photonic structures, advanced nanofabrication strategies, and the development of novel nanophotonic concepts for sensing, light-matter interaction, and quantum technologies.

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