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NANOFABRICATION
MAKE IT AT BIRCK
PURDUE
UNIVERSITY

Pushing the boundaries of *POSSIBLE*

The Birck Nanotechnology Center is an ultra-high-performance fabrication and characterization research facility that educates the researchers and technical workforce of tomorrow. Our center is home to a talented team of researchers, engineers and scientists who are committed to pushing the boundaries of what's possible in nanotechnology. Researchers leverage Birck's state-of-the-art facilities and equipment, including the 25,000 sq. ft. Scifres Nanofabrication Laboratory cleanroom and advanced nanofabrication and characterization tools, to conduct research in the design, fabrication, and characterization of materials and devices at the nanoscale and integration at the advanced system and packaging level.

Research at Birck leads to fundamental science discoveries and development of new technologies that can revolutionize industries.

At Birck, we believe that collaboration is key to achieving breakthroughs. We have strong internal collaborations among faculty, researchers and staff engineers, and we work closely with partners from other academic institutions, industry, and government. We serve as a platform for public and private partnership, bringing together diverse expertise and resources to address pressing challenges in the field of nanotechnology.

Front cover: Neil Dilley, research scientist at Birck
(Purdue University/Charles Jischke)

Scifres Nanofabrication Laboratory
(Purdue University/Charles Jischke)

PURDUE BOASTS ONE OF THE WORLD'S LARGEST UNIVERSITY CLEANROOMS

The Scifres Nanofabrication Laboratory at Birck Nanotechnology Center is a 25,000 sq. ft. cleanroom with a complete toolset for processing coupon scale up to 200 mm (8") wafers. 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), Scifres is equipped for leading edge collaborations with both academia and industry. The three-level structure consists of a full subfab, the cleanroom level, and an air-handling level above the cleanroom. A perforated raised floor ensures unidirectional airflow and bulkhead-mounted equipment separates operational functions from maintenance functions. A combination of careful control of the airflow path, multiple stages of filtration, careful choice of materials, and non-ionic-steam humidification ensure the control of both particulate and molecular contamination. A very tight waffle slab provides NIST "A" vibration rating, approximating quiet, slab-on-grade construction.

The facility ultra-pure water (UPW) system supplies all laboratories and the cleanroom with incredibly pure "nano-grade" water containing no measurable amount of dissolved boron (< 15 parts per trillion). Boron is the ion most loosely bound to the mixed beds and therefore the most likely ionic impurity in the water. This water also contains less than 225 parts per trillion of total oxidizable carbon (TOC) and less than 1 part per billion of dissolved oxygen.

Scan this QR code for a **virtual tour** of the Scifres cleanroom at Birck

PATTERNING

Resist patterns are used in conjunction with deposition and etching to make micro- or nano-structures using processes such as lift-off or etch. Patterns can also be made by 3D printing or nano-imprinting into resists.

Electron beam lithography

JEOL JBX-8100FS, Raith e-Line: resolutions down to 7 nm, scan speeds up to 125 MHz, beam energy up to 100 kV, wafers up to 6".

Optical lithography

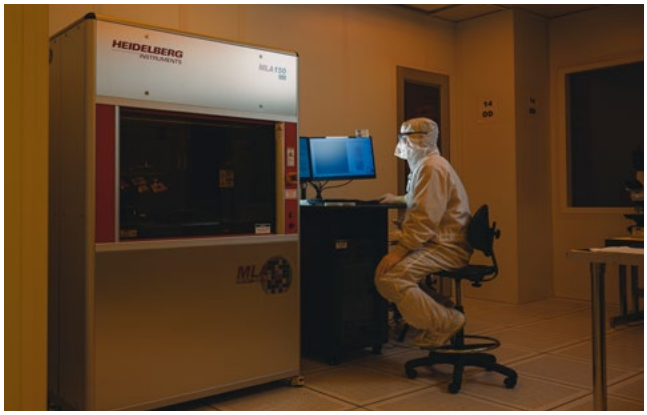
Heidelberg MLA150: maskless aligner for mask-making or high speed direct write photolithography; up to 8" wafer. *Suss MA6, MJB3, MJB4* mask aligners.

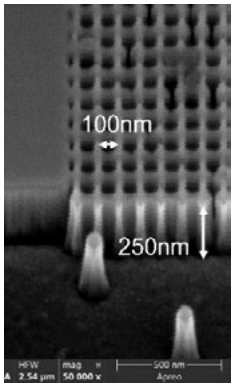
Other highlights

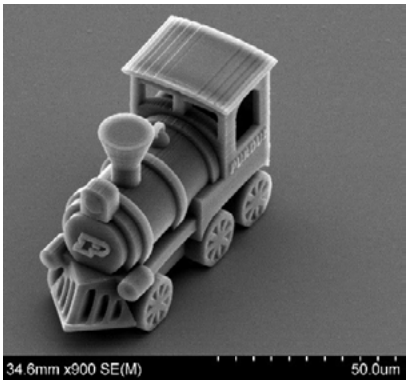
Nanoscribe Photonic Professional GT2 3D Printer: Two-photon polymerization (2PP)-based 3D printing of nano-, micro- or meso-scale objects.

Nanonex NX-2000: nano-imprint lithography; thermal (250° C) or photo (UV) imprinting with <10nm resolution, pressure up to 550 psi, up to 8" wafer.

PLS6MW Multi-Wavelength Laser Cutter: large 32" x 18" work area, up to 75 watts, wavelengths of 1.06 and 10.6 µm.



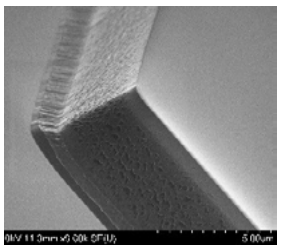


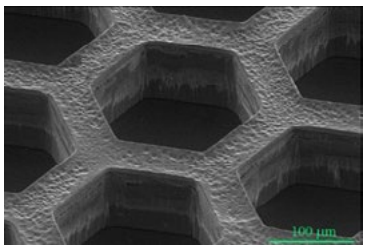


DEPOSITION

At Birck, over 30 systems provide a variety of methods to deposit over 60 different metals, dielectrics, and organics. Capabilities include:

- Atomic Layer Deposition (ALD)
- Chemical Vapor Deposition (CVD)
- Plasma Enhanced Chemical Vapor Deposition (PECVD)
- High Density Plasma CVD (HDPCVD)
- E-beam Evaporation
- DC/RF Sputtering
- Multi-deposition (E-Beam Evaporation + Sputtering)
- GaN Molecular Beam Epitaxy (MBE)
- PVD Pulsed Laser Deposition (PLD)
- Electrodeposition





ETCHING

In addition to wet etching chemical hoods available inside and outside the Scifres cleanroom, there are many dry etching tools within the cleanroom for reactive ion etching (RIE), deep reactive ion etching (DRIE), asher, ion milling and vapor phase etch with a wide variety of chemistries available.

Reactive ion etching (RIE): tools include Panasonic E620, Plasma-Therm Apex SLR, March Jupiter II Etcher, STS AOE, STS ASE. Available gases include O_2 /Ar / SF_6 / CHF_3 / CF_4 / Cl_2 / N_2 / BCl_3 / H_2 / C_4H_8.

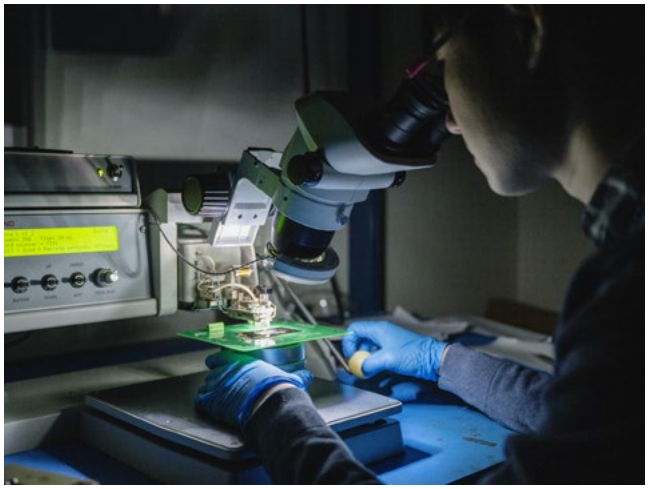
Physical etching: Two *AJA Argon Ion Mill* systems (for 6" and 8" wafers) with SIMS-based endpoint detection.

Ashing: *Tergeo Plasma Cleaner*

Vapor-phase etching: *Xactix e-1, XeF_2 Etcher*

ANNEALING

Various thermal processing equipment is available for oxidation, chemical vapor deposition, and annealing. The Expertech furnaces (9 tubes available) are horizontal quartz tubes that can process many wafers up to 8" (200mm) at once in many configurations. Expertech processes include wet and dry oxidation, CVD nitride and oxide, forming gas annealing, and polysilicon. Other available controlled atmosphere thermal processes include H_2S CVD, nitric oxide, and nitrogen anneal. Rapid and traditional thermal annealing is provided by the *Jipelec RTA* and *Blue M* furnaces. Typical maximum temperature allowed is 1100°C.



WAFER PROCESSING AND PACKAGING

Also referred to as back-end processing, these capabilities including bonding, dicing and polishing.

Thermosonic wire bonding:
Westbond 7476E wedge bonder; two units are available, one set up for 25 µm gold wire bonding and the other for 25 µm aluminum wire bonding.

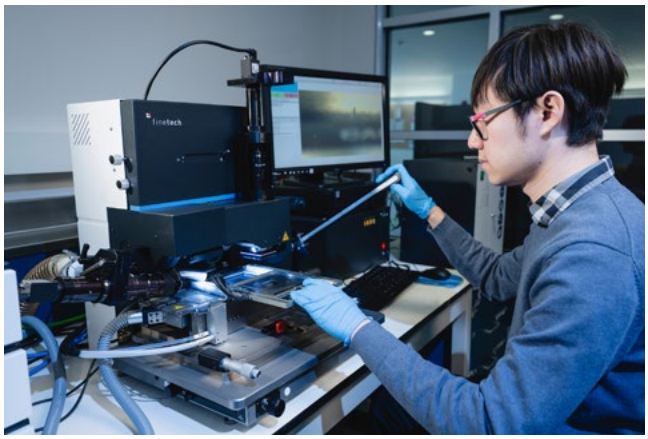
JFP WB-100; general purpose ball/wedge/ribbon bonder, typically set up for ball bonding 25 µm Au wire.

Dicing saw: *Accretech SS20*; up to 8" (200mm) wafers and up to 1 mm thick.

Chemical and mechanical polishing (CMP): *ASAP-1 IPS Automated Mechanical Polisher*

ADVANCED PACKAGING

A dedicated laboratory for performing advanced packaging that enables high density, multi-chip modules in both a stacked and planar configuration. Tools include the *G&P Technology POLI-500* Chemical-Mechanical Polisher (CMP) for both conductors and insulators, the *IKO 8" electroplating system*, two wafer thinning systems, the *Finetech Fineplacer Lambda 2* flip chip bonder, and the *Nordson Sonoscan* Surface Acoustic Wave microscope.



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For more information on Birck's facility resources including characterization and nanofabrication.

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