UNIVERSITY OF NOTRE DAME
Nanofabrication Facility ndnf

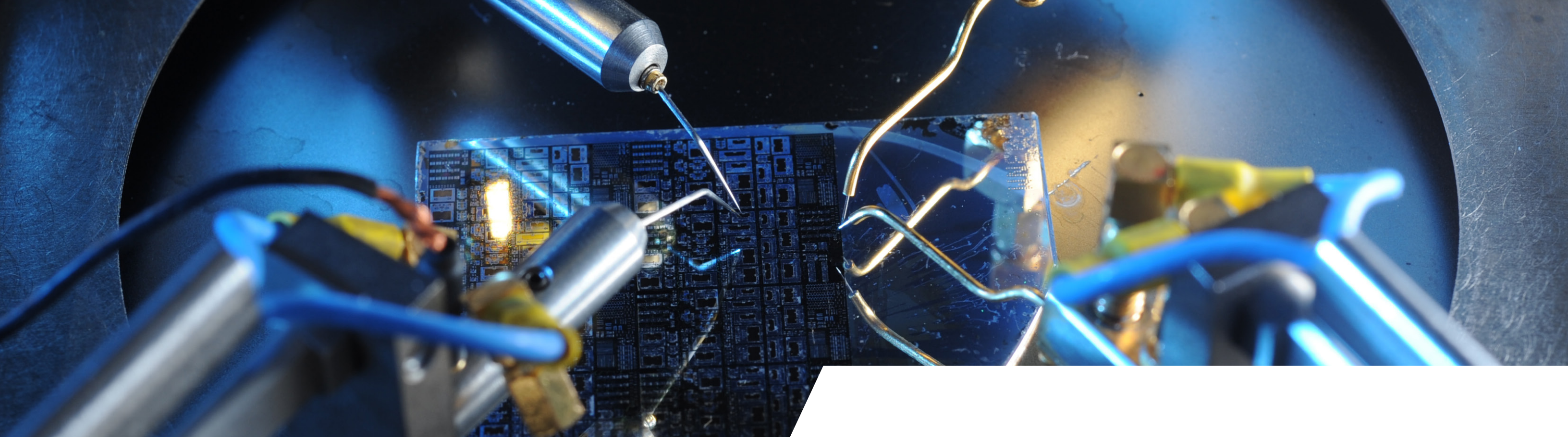
The Notre Dame Nanofabrication Facility is the equipment set and supporting cleanroom environment for research and teaching in nanoelectronics, optoelectronics, microfluidics, nanofabrication, and related disciplines. The facility consists of a 9,000 square foot clean room and a full complement of processing and test equipment necessary for fabricating and analyzing the performance of advanced devices.

Cleanroom

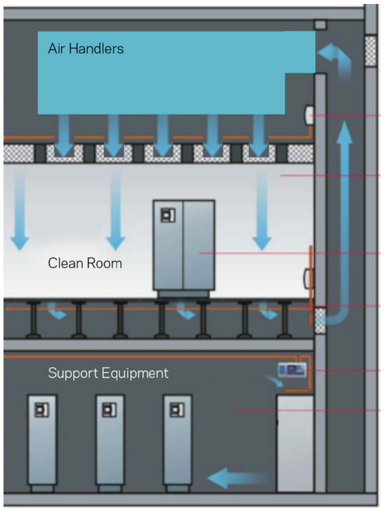
A cleanroom is an environment that has a low level of environmental contaminants such as dust, airborne microbes, aerosol particles and chemical vapors. Clean rooms are classified by the number of particles per cubic foot of a specified particle size. The NDNF has three sections in its clean room, a 1,227 square foot Class 10,000 bay, a 2,336 square foot Class 1,000 bay and a 2,700 square foot Class 100 bay. Roughly speaking, this means that the air in the Class 100 area (the largest region, within the amber-tinted windows) has fewer than 100 particles larger than 0.5 µm in diameter per cubic foot of air. As a reference, typical outside air in an urban environment contains over 1 million particles per cubic foot, and is thus 10,000 times less clean than within the NDNF.

Cleanroom Air Treatment

Air inside the cleanroom is constantly recirculated through High Efficiency Particulate Air (HEPA) filters. The air enters uniformly through the ceiling (most of the ceiling tiles are actually filters) and flows with as little turbulence as possible to the floor. To support the cleanliness requirements, the building has been carefully designed. The cleanroom and its support equipment occupy a 3-story "envelope" within the building. The main working level on the first floor is the clean space and is where the research activities take place. Air handlers, filters, and controls are on the second floor above (see the windows at the top of the atrium stairs); the double glass walls that you look through form a return air plenum that returns the air back up to the air handlers on the second floor. The air handling system circulates approximately 250,000 cubic feet of air per minute to maintain cleanliness within the lab. The floor below (in the basement) houses support hardware for the research tools on the main floor, such as an ultra-pure water system, vacuum pumps, gas and electrical supply, etc.



Contamination Control



Staff enter and leave through airlocks and wear protective clothing such as hoods, face masks, gloves, boots and coveralls (often called “bunny suits” for reasons that are clear if you see them working in the cleanroom). Even simple things like cellulose-based office paper generate too many particles to be used in a cleanroom; researchers use special plastic-fiber based “paper” instead. Equipment inside the cleanroom, and materials used to construct the cleanroom, are selected to create minimal contaminants. Cleanroom furniture is also designed to be easy to clean. Semiconductor clean rooms are kept at a positive pressure compared to the environment to prevent outside air from leaking in with unfiltered particulates.

Additional Features

To support the research and tooling in the lab, the facility has been designed to be more than just clean. Nanoscale patterning requires low vibrations, low levels of electromagnetic interference, and accurate temperature and humidity control. Floor vibrations are carefully controlled, and meet or exceed VC-E (≤ 100 μin/sec RMS velocity) in critical locations, and the measured AC magnetic fields within the cleanroom are below 0.1 mG (for comparison, the earth’s DC magnetic field is around 500 mG in northern Indiana). Ambient noise is also minimized, with a noise level below 60 dBa typical. Temperature and humidity are actively controlled to 69 °F ± 0.5 °F and 40% ± 5%. Since photolithographic processes typically use ultra-violet sensitive chemicals (photoresists), amber lighting and window tints are used in the class 100 area to prevent any stray light from interfering with the process.

Equipment

The equipment set within the cleanroom includes tools to implement all of the processing steps typically used in the fabrication of electronic devices (such as transistors), optoelectronics (such as lasers and photodetectors), microfluidic devices, and novel nanodevices. These capabilities include high-resolution lithography, with spatial resolution to below 8 nm (Vistec 5200 electron beam lithography); optical lithography; deposition of metal, dielectric, and semiconductor films; etching of metals, dielectrics, and semiconducting materials by both wet and dry chemical processes; and metrology techniques to support these processes.

Contact NDNF

Patrick Fay
NDNF Director
Professor of Electrical Engineering
(574) 631-5693
pfay@nd.edu

Mark Richmond
NDNF Lab Manager
(574) 631-7493
mrichmon@nd.edu

nd.edu/~ndnf

UNIVERSITY OF NOTRE DAME | COLLEGE OF ENGINEERING