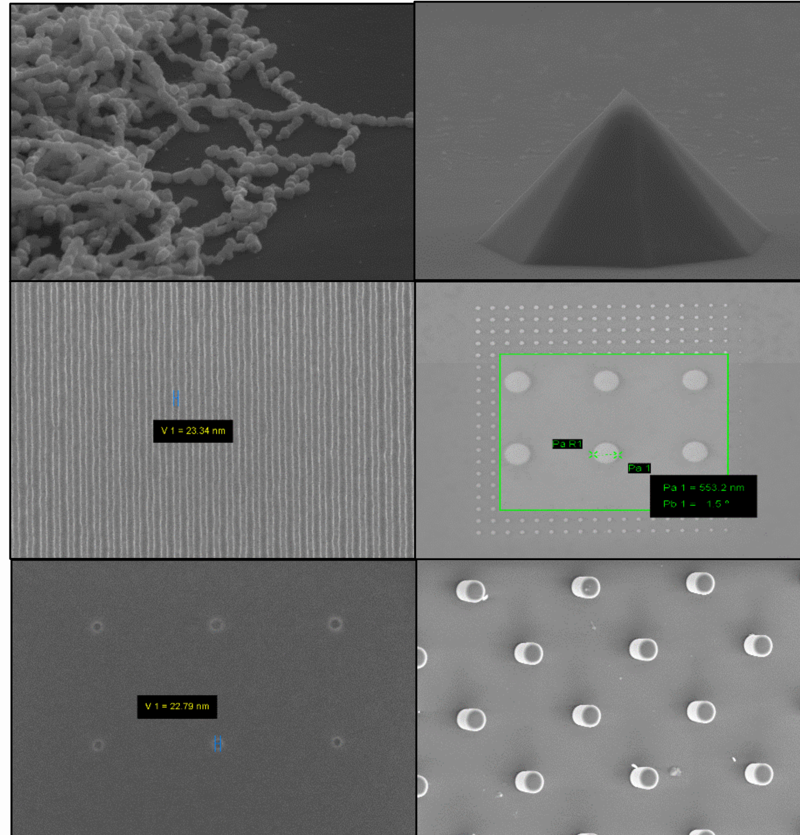
N2fC

National
Nanofabrication
Centre

Developments in Lithography



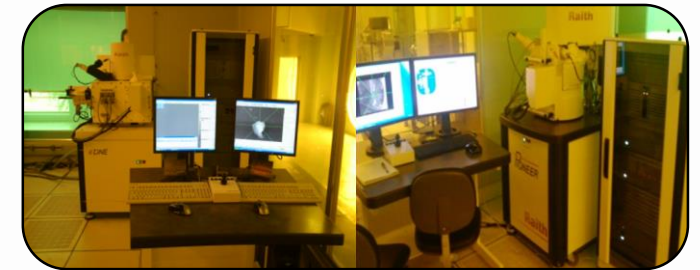
Contact us :

National Nanofabrication Centre
Centre for Nano Science and Engineering
Indian Institute of Science
Bengaluru-560012, India
nanogopal@cense.iisc.ernet.in
http://www.cense.iisc.ernet.in/infrastructure.htm#nano

E-Beam Lithography

Electron Beam Lithography (EBL) allows users to write patterns with extremely high resolution, smaller than 10nm in size. It makes use of a highly energetic, tightly focused electron beam, which is scanned over a sample coated with an electron-sensitive resist. The electron beam scans the image according to a pattern defined on a CAD file. The sample is then developed in an appropriate solvent which reveals the structures defined into the resist. This acts as a mold for subsequent pattern transfer techniques such as dry etching or metal lift-off. Due to the high-resolution nature of the technique, EBL has a vast range of applications including, but not limited to, nano-electronics, photonics, plasmonics, nano-fluidics, MEMS, x-ray and neutron optics.

NNfC has world class e-beam lithography facility with class 100 clean room and expertise in patterning of sub-20nm features. NNfC consists of Raith-E-LiNE, Raith-Pioneer systems with the following features and process capabilities. Various EBL patterns can be done with different resists like PMMA, HSQ, ma-N 240, EL9 and etc.



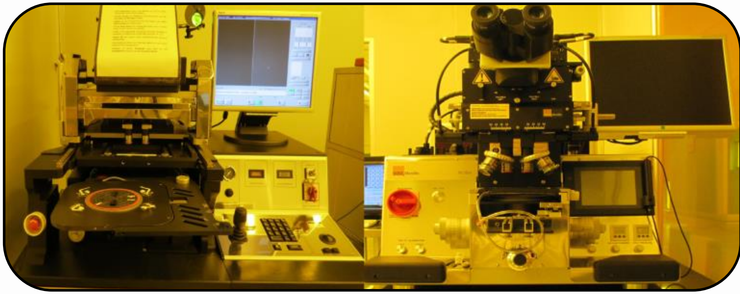
Raith-E-Line

- Ultra high resolution electron beam lithography system and nano-engineering workstation.
- Maximum acceleration voltage : 30 kV
- Can also perform top view and cross section SEM
- Sub 10nm minimum feature dimensions
- Electron Beam Induced Deposition (EBID)
- Electron Beam Induced Etching (EBIE)
- Nanomanipulators

Raith-Pioneer

- Compact Electron Beam Lithography system with Thermal Field Emission technology
- Capable of sub 20nm lithography
- Maximum accelerating voltage 30kV and 7 apertures
- Morphology and Cross – section of various samples can be analysed
- Perfectly suited for write and view applications of samples with 2” area

Photolithography



Photolithography, also termed as Optical lithography uses light to transfer a geometric pattern from photomasks to a photo-sensitive chemical "photoresist". Class 100 cleanroom of Lithography section at National Nanofabrication Centre, IISc houses two tools for optical lithography.

EVG620 is a "SEMI-AUTOMATIC" Contact Photo-Lithographic Alignment and Exposure Tool with a capability of handling upto 6" wafers. It also has the Capability of Front to Back Alignment of Patterns and Aligning wafer stack for the Anodic bonder. Recipes for different Exposure types and Contact Modes can be Pre-Written and is very User friendly. The equipment for Optical Lithography allows for selectively masking and exposure of certain areas of the sample substrate using a ”MASK” and ”SET OF MASK”. Masks are realized in advance by Laser Writer by Etching a Thin Metallic Layer deposited onto a special Glass Slide.

Suss MicroTec Mask aligner is a "SEMI-AUTOMATIC" Contact Photo-Lithographic Alignment and Exposure Tool with a capability of handling upto 4" wafers. It also has the capability of Front to Back Alignment with IR alignment. The machine also allows Deep UV exposures and also has the feature to perform Nanoimprint-lithography.

The Laurell spin processors handles up to 6” wafers. The machine can be operated manually, which renders it especially suited for experimental spinning of different resists.

Photolithography Equipment

Resist types
- AZ5214E
- AZ4562
- AZ nLOF 2070
- Shipley series
- SU8 (2002-2150)
- LOR (Lift-off resist)

Coaters
- Laurell Spin Processor, Model No:WS-650MZ-23NPP

Baking
- VENTICELL OVEN
- IKA-C-MAG HS7 Hot Plate

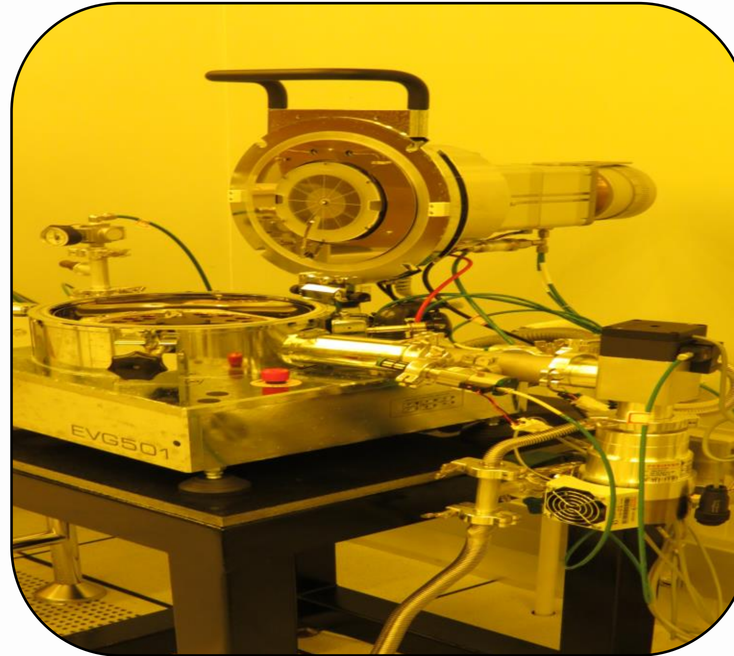
Mask Aligners
- Karl-Süss MJB4
- EVG 620 Double Sided Mask aligner

Nano Imprint Lithography
- Karl-Suss MJB4

Optical Inspection
- Leica DM 2500M,
- Leica DM 750,
- Leica S6D

Wafer Bonder

The lithography section also houses a EVG501 Wafer Bonder which has the capability of Bonding 4" wafers. The machine allows Anodic bonding, Eutectic bonding and Fusion bonding. Aligning wafer stack on EVG620 Mask aligner and anodically bonding the wafer stack on EVG bonder is also possible.



Tool specifications:

Wafer/ Substrate Parameter : Up to 4 Inch Substrate and Quarter Wafer pieces can be handled
- Alignment Accuracy : 0.5µm for Glass/Silicon and 1µm for Silicon/Silicon
- Types of bonding Available: Eutectic bonding, Anodic bonding and Fusion bonding
- Adjustable from 0.5N – 40N
- Bond temperatures up to 450°C
- High-vacuum capable bond chamber (down to 10-5 mbar with turbo molecular pump)
- Temperature uniformity <+/- 1%
- Pressure uniformity <+/- 5%

Mask Writer

In general term lithography refers to a process in which a surface is patterned by coating it with resist then forming a desired stencil pattern on the resist and transferring the pattern into the surface. A variety of energy sources can be used for exposing the resist pattern such as x-rays, Laser, LED,UV or electron beams. When optical photons are used, the process is called as photolithography. Photolithography is the main technique for micro structuring of electronic devices in microelectronics. One such technique which uses laser beam/ LED to form the desired patterns on the photoresist is called laser /LED writing (Direct writing).

The specialty of the Mask Writer is that it can be used for direct pattern generation on any substrate using photolithographic principles without using a conventional mask plate. The main purpose of the Mask writer is to make photolithographic mask reticles and masks up to 5inch in size can be made by Microtech LW-405 & Heidelberg µPG 501 system.

Tool Specifications:

- Exposure Wavelength - 405nm for Microtech Laser Writer and 390nm for Heidelberg µPG 501
- Printing Resolution – 1.2 µm direct write, 3 µm on soda lime mask plate.
- GDS-2 and CIF Formats can be used.
- High Resolution Multi-Layer patterning capability using Alignment marks
- Primarily used for Mask Writing