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Enabling 2D Material With Direct Write Lithography

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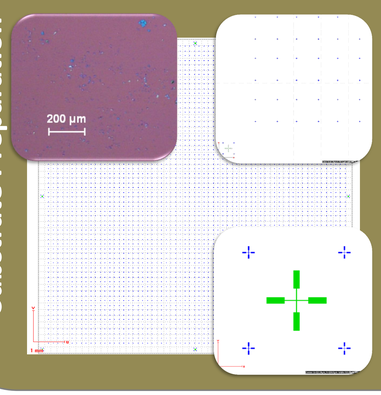
Abstract

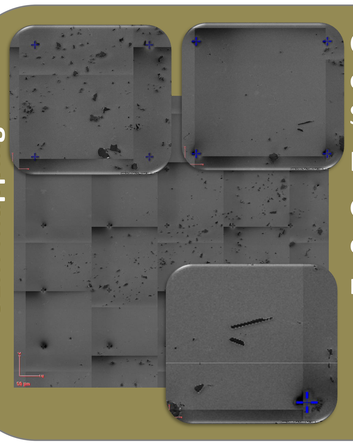
More and more researchers are turning to 2D materials as a solution for future electronic devices and sensors. Many of these 2D materials are supplied by transferring flakes onto a substrate or growing islands of CVD materials. We have been able to take advantage of our unique tool set of **Raith ionLINE** (ion beam lithography), **Raith 150** (electron beam lithography), and the **Heidelberg DWL66** (laser lithography) and when employed in concert, we are able to mill, map, and process randomly distributed 2D materials into functional devices on substrates up to 100mm diameter.

Substrate Preparation



Starting with a substrate that includes randomly distributed 2D material, fiducial marks can be placed by direct milling or lift off process.

SEM Mapping



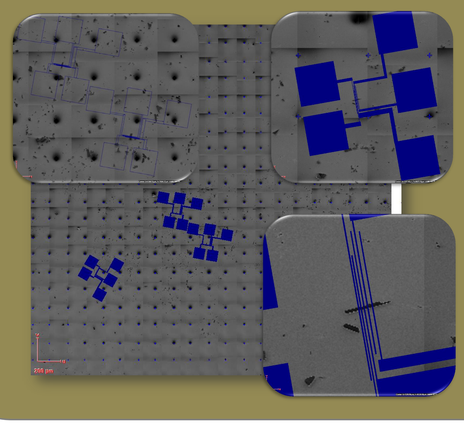
Once fiducial marks are in place, entire substrate is mapped via SEM with the Raith 150.

Images are tiled together.

GDS of fiducial marks is then overlaid over SEM tiled image.

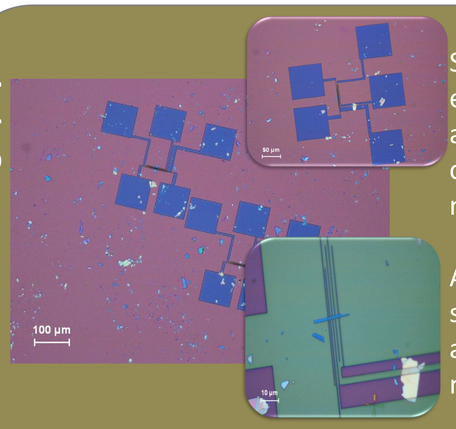
EX: 1mm^2 image (200um field)
time = 125s
1cm^2 image (200um field)
time = 3.4hrs
both at 150nm^2/pix resolution (500x)

GDS Image Overlay



Areas of interest are identified and GDS designs placed over material image using GDS/Image overlay.

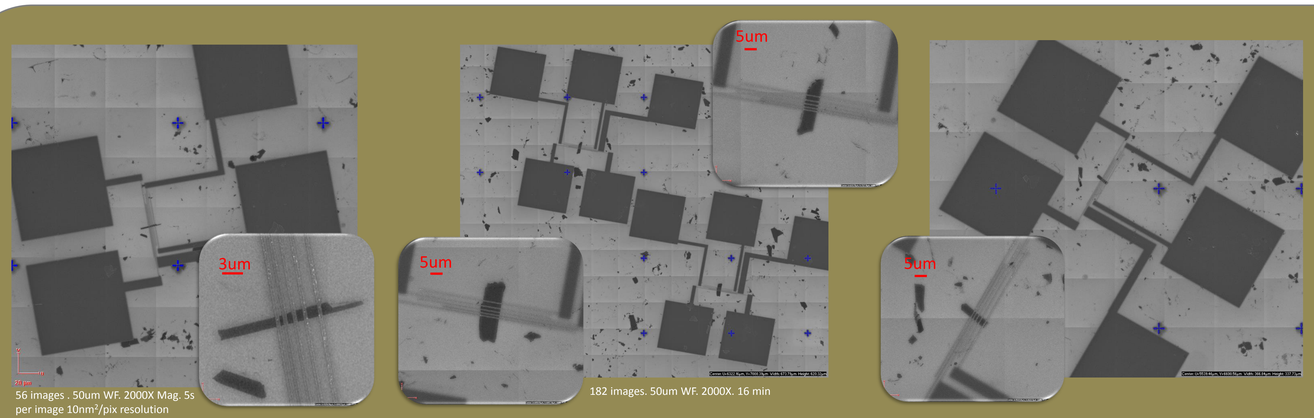
E-beam Lithography



Sample is coated with ebeam resist (300nm) and GDS file calibrated to existing milled fiducial marks.

After write is finished, sample is developed and ready for metallization.

Metal Lift Off



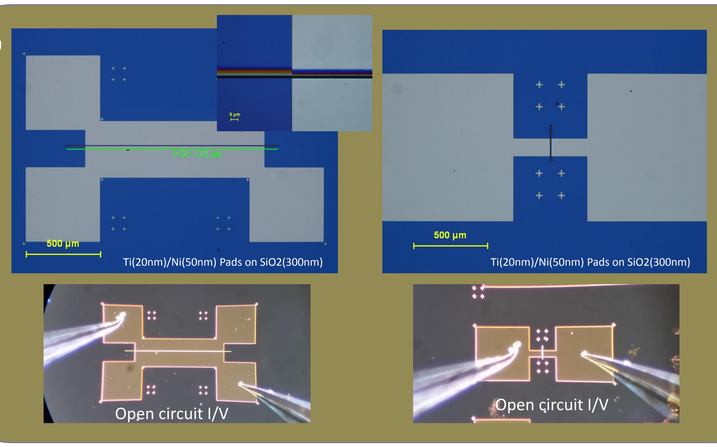
56 images . 50um WF. 2000X Mag. 5s per image 10nm^2/pix resolution

182 images. 50um WF. 2000X. 16 min

Metal deposition is done via e-beam evaporation.

In this case, 20nm of Ti and 50 nm of Ni are deposited and lifted using standard lift off techniques.

Stitch-free Isolation Milling

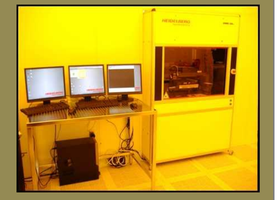


State-of-the-art ionLINE lithography system is capable of milling long areas without stitching by implementing Fixed Beam Moving Stage (FBMS) mode.

Multi-species ion source (currently AuSi) and IBID available.

Nanoscale Research Facility

- Class 100-1000 cleanroom for nanofabrication and bio/nano processing (7000sqft) with full 100mm wafer capability (some 150mm capability)
- Labs for nanofabrication, advanced imaging, and characterization of nanostructures
- Labs for device assembly and processing, and sample preparation and characterization
- Separate fabrication labs for education
- Full time engineering staff to assist with or conduct the fabrication processing



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