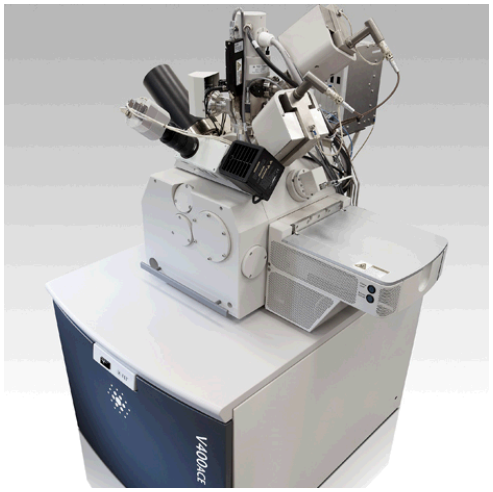
SAND2016-0975PE



FIB/SEM Circuit Edit and Imaging

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Sandia National Laboratories

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U.S. DEPARTMENT OF ENERGY

NNSA National Nuclear Security Administration

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CE and Imaging Capabilities

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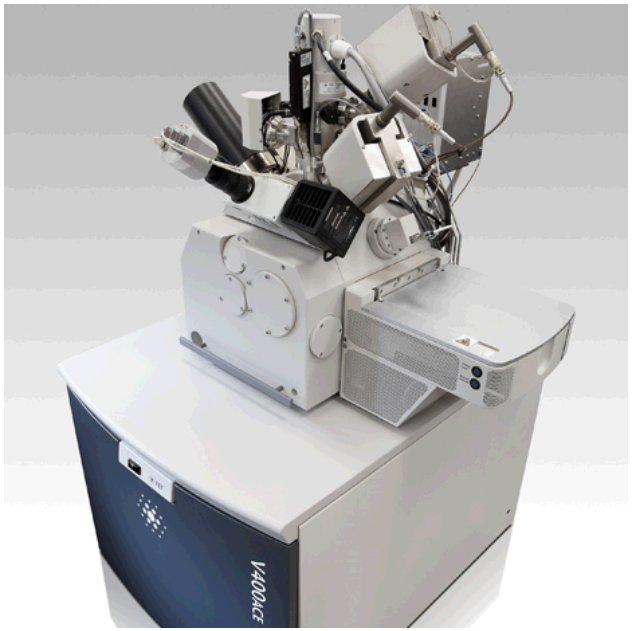

V-400 backside FIB
Circuit edit
Back- and front-side edits
45 nm capability

Dual-beam Helios
Imaging and circuit edit
Cross-sections – slice and view
45 nm capability

Magellan SEM
Imaging
0.9nm resolution @<1kv

V-400 FIBs

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CE

Nano-Chemix

- W deposition
- SiO_2 deposition
- Cl_2 etch
- XeF_2 etch
- H_2O etch

Gas Injection Systems

- XeF_2 IEE etch
- Dx etch
- De etch

Specifications

- Ion column
  Tomahawk – Ga LMIS
- Acceleration Voltage: 0.5 – 30 kV
- Beam current: 1.1pA – 65 nA
- Image resolution: 4.5 nm
- Stage:
  x,y motion: 100 mm
  tilt: -10 – 60
  rotation: 360

Features

- IR imaging
- Stageless navigation
- S-mill
- Drift compensation
- CAD layover
- Charge neutralizer

Concerns:

- CE capability below 45 nm
- Standard baseline process definition
- Improved navigation
- Improved IR imaging
- Dx process development
- Interaction with applications lab
- Communication about new capabilities
- Possible technical collaborations

Dual-Beam Helios

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FIB

CE capability:

- Pt deposition
- SiO_2 deposition -TEOS
- De etch

Specifications:

- Ion column
  Sidewinder – Ga LMIS
- Acceleration Voltage: 0.5 – 30 kV
- Beam current: 1.5 pA – 20 nA
- Image resolution: 3.0 nm
- 5-axes motorized x-y-z-rotate-tilt stage with piezo control of all axes
  travel along the x and y-axis is 150 mm
  tilt range is –10 to 60 degrees

SEM

Imaging capability:

- Cross-sections
- Slice and view

Specifications:

- Ultra-High Resolution electron optics (magnetic immersion lens and ultra-high brightness Elstar emitter)
- Resolution: 0.9nm @<1kV
  0.8nm @>5kV
- 5-axes motorized x-y-z-rotate-tilt stage with piezo control of all axes
  travel along the x and y-axis is 100 mm
  tilt range is –10 to 60 degrees

Concerns:

- Standard baseline process definition
- Optimization of oxide deposition process
- Interaction with applications lab
- Communication about new capabilities
- Possible technical collaborations

Magellan SEM

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- Ultra-High Resolution electron optics (magnetic immersion lens and ultra-high brightness Elstar emitter)
- UC technology for beam energy spread below 0.2 eV
- Beam deceleration for low-kV work
- Cryo-cleaner and plasma cleaner
- Detectors: in-lens SE and BSE
- Resolution: 0.9nm @<1kV
- 0.8nm @>5kV
- 5-axes motorized x-y-z-rotate-tilt stage with piezo control of all axes
- Travel along the x and y-axis is 100 mm
- Tilt range is –10 to 60 degrees

Concerns:

- Stage errors due to skipping
- Cleaning and and new cables has not fixed the problem
- This has been one of our biggest issues – cannot dependably use the MAPS software
- Plans for high-frequency nanoprobes?