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FEI Helios NanoLab 400S FIB-SEM

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Abstract: The FEI Helios NanoLab 400S FIB-SEM is one of the world's most advanced DualBeam™ focused ion beam (FIB) platforms for transmission electron microscopy (TEM) sample preparation, scanning electron microscopy (SEM) imaging and analysis in semiconductor failure analysis, process development and process control. The FEI Helios NanoLab 400S FIB-SEM combines an Elstar™ electron column for high-resolution and high-contrast imaging with a high-performance SidewinderM ion column for fast and precise cross sectioning. The FEI Helios NanoLab™ 400S is optimised for high throughput high-resolution S/TEM sample preparation, SEM imaging and energy dispersive X-ray analysis. Its exclusive FlipStage™ and in situ STEM detector can flip from sample preparation to STEM imaging in seconds without breaking vacuum or exposing the sample to the environment. Platinum gas chemistry is the preferred metal deposition when a high deposition rate and precision of the deposition are required. Carbon deposition can be chosen as well. The system additionally allows for spatially resolved compositional analysis using the attached EDAX Genesis XM 4i X-ray microanalysis system.

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1 System Overview

Figure 1: FEI Helios NanoLab™ 400S FIB-SEM (photograph by courtesy of FEI company).

2 Typical Applications and Limitations of Use

The configuration of the FEI Helios NanoLab 400S allows a variety of advanced imaging and preparation techniques to be applied to wide bunch of solid state materials. These techniques include TEM sample preparation (normal- and backside milling) without breaking the vacuum, STEM imaging on thin TEM samples, needle preparation for tomography, plan-view preparation and the preparation of lamellas on heating chips for TEM annealing experiments.
The FEI Helios NanoLab 400S is not intended for the investigation of aqueous, ferromagnetic or organic samples without further discussions with both of the instruments officers and the ER-C general management.

3 Basic Electron and Ion Optics Set-up

- Elstar UHR immersion lens FE-SEM column
- electron gun with Schottky thermal field emitter
- Sidewinder ion column
- gallium liquid ion source

4 Electron and Ion Optics Specifications

- electron landing voltage 350 V ... 30 kV
- ion landing voltage 500 V … 30 kV
- magnification range 25 ... 650 k
- image processor 4096 x 3536 pixel
- electron beam resolution @ optimum distance 0.8 nm 30kV (STEM)
- electron beam resolution @ optimum distance 0.9 nm 15kV
- electron beam resolution @ optimum distance 1.4 nm 1kV
- electron probe current $\leq$ 22 nA
- ion beam resolution coincident point 5 nm 30kV
- ion beam current 1.5 pA – 21 nA

5 Detectors

- Elstar in-lens SE detector (TLD-SE)
- Elstar in-lens BSE detector (TLD-BSE)
- Everhardt-Thornley external SE-detector (ETD)
- external secondary electron and secondary ion detector (CDEM)
- retractable STEM detector BF/ DF / HAADF
- electron or ion beam current measurement

6 Specimen Stages and Sample Loading

- high precision 5-axis motorised stage
- XY movements: 150 mm piezo-driven
- Z movement: 10 mm motorised
- tilt: -10° to +60°
- rotation: n x 360° (endless) piezo-driven
- FlipStageTM for integrated TEM sample preparation and STEM imaging
- OmniprobeTM Auto Probe 200 in situ sample lift-out system
- loadlock for fast sample transfer

7 Gas Injection System

- platinum deposition
- carbon deposition

8 Energy Dispersive X-ray System

- EDAX Genesis Integration Kit
- Genesis XM 4i motorised SUTW Detector