Novel Tools for NanoPrototyping using DualBeam FIB/SEM
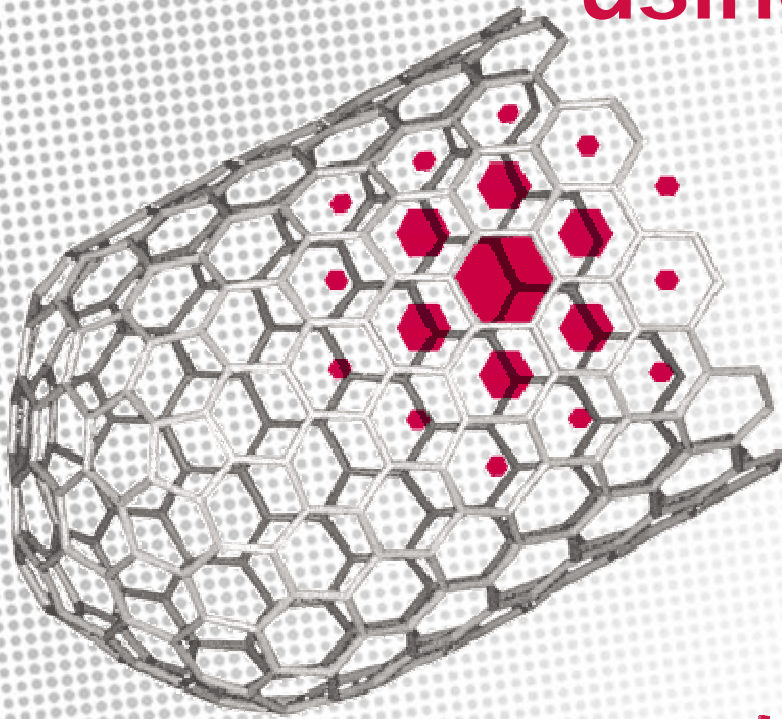
Steve Reyntjens

FEI Eindhoven, NL

NANOSPAIN 2008
Braga (Portugal) April 14-15, 2008
NanoIberian Conference

April 15, 2008

FEI COMPANY™

TOOLS FOR NANOTECH

FEI™

FEI Company

PHILIPS
Electron Optics

1949 Eindhoven, NL

FEI

1971 Hillsboro, OR
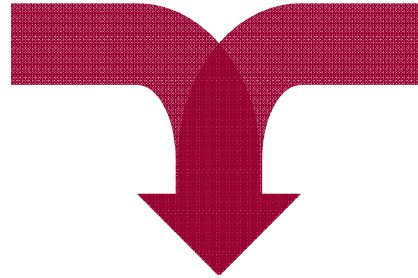
1997 Merger

FEI COMPANY
TOOLS FOR NANOTECH

TOOLS FOR NANOTECH

Scanning Electron Microscopes

Transmission Electron Microscopes

Titan™ 80-300

Expanding the Boundaries
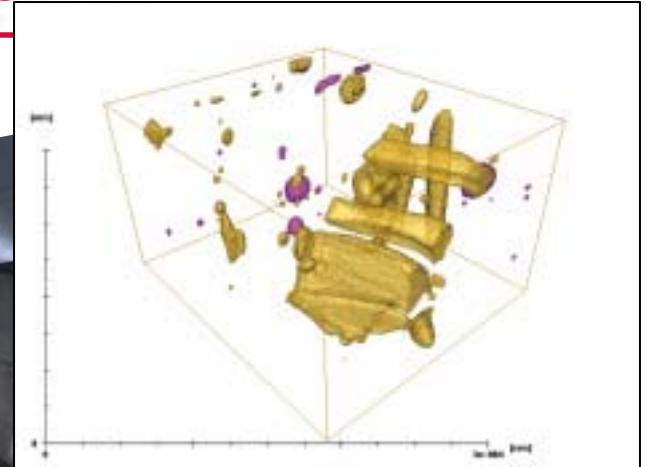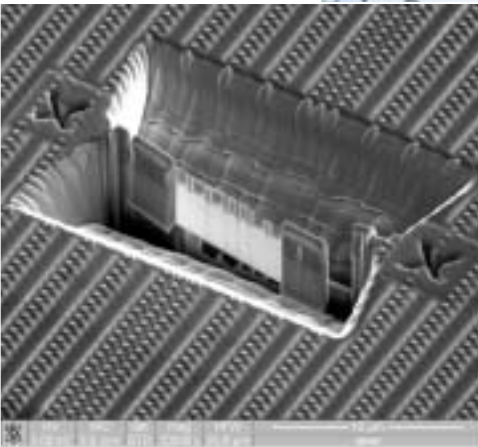and Achieving New Results

DualBeams

Traditional DualBeam Applications
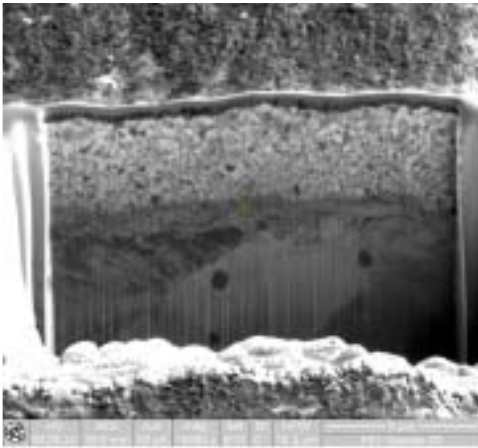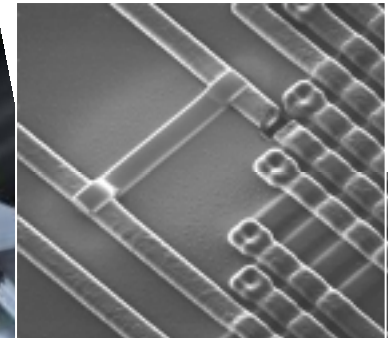
Cross Sectional
Imaging & Analysis

3D Imaging

TEM Sample Preparation

Circuit Edit

DualBeam NanoPrototyping and NanoFabrication

Rapid Prototyping

direct FIB-milling

gas assisted FIB-milling

FIB deposition

e-beam deposition

Proof of concept: **device**

NanoFabrication

electron beam lithography

Conventional batch fabrication processes: dry etch, wet etch, PVD, PECVD, electroplating, self-assembly, ...

DualBeam inspection & analysis

Proof of concept: **batch process**

The **combination** of patterning with **FIB** and **e-beam** has the potential to produce a prototype fast, solve critical processing steps more efficiently and show a route for batch fabrication.

FEI™

FIB-Patterning – How it works

- **Digital Patterning Board**
  - Design (geometry) is broken down into discrete dwell points
  - DACs (X, Y, t) control beam positioning and timing – relative to field of view;
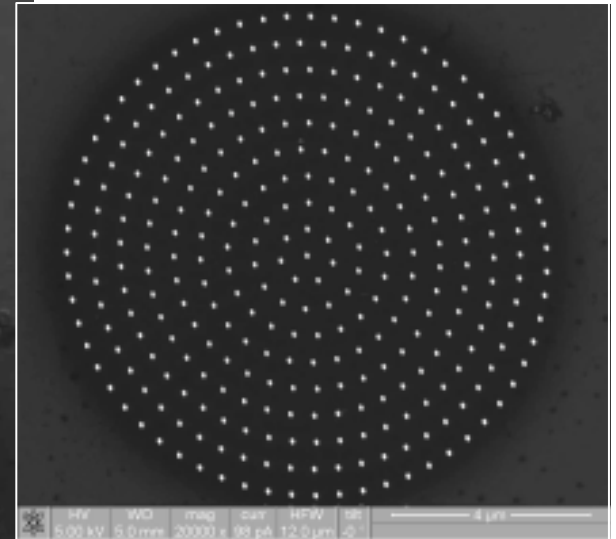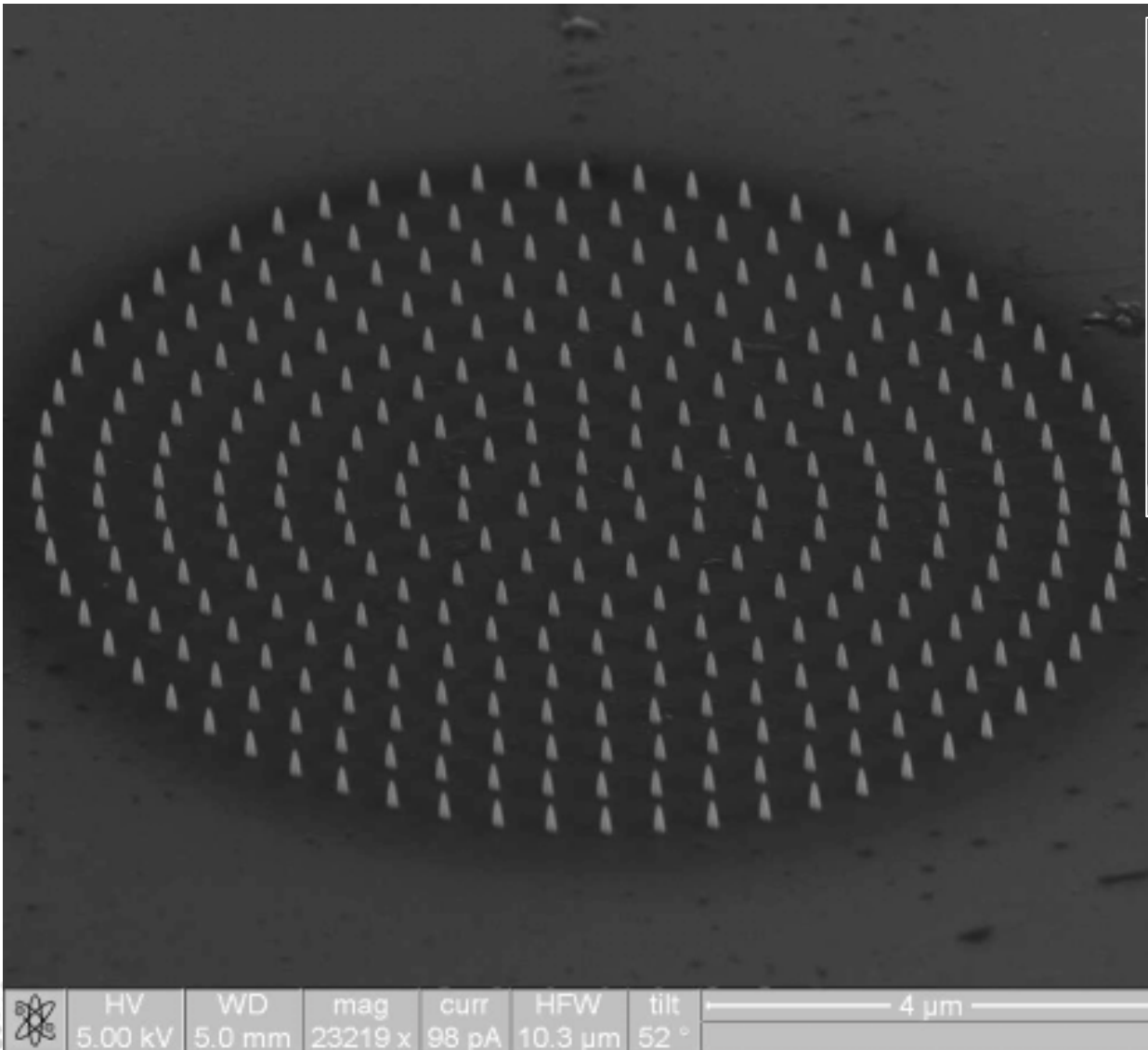 - Ion beam or electron beam

FEI

UI Patterns – Example: Contacting nanoWires
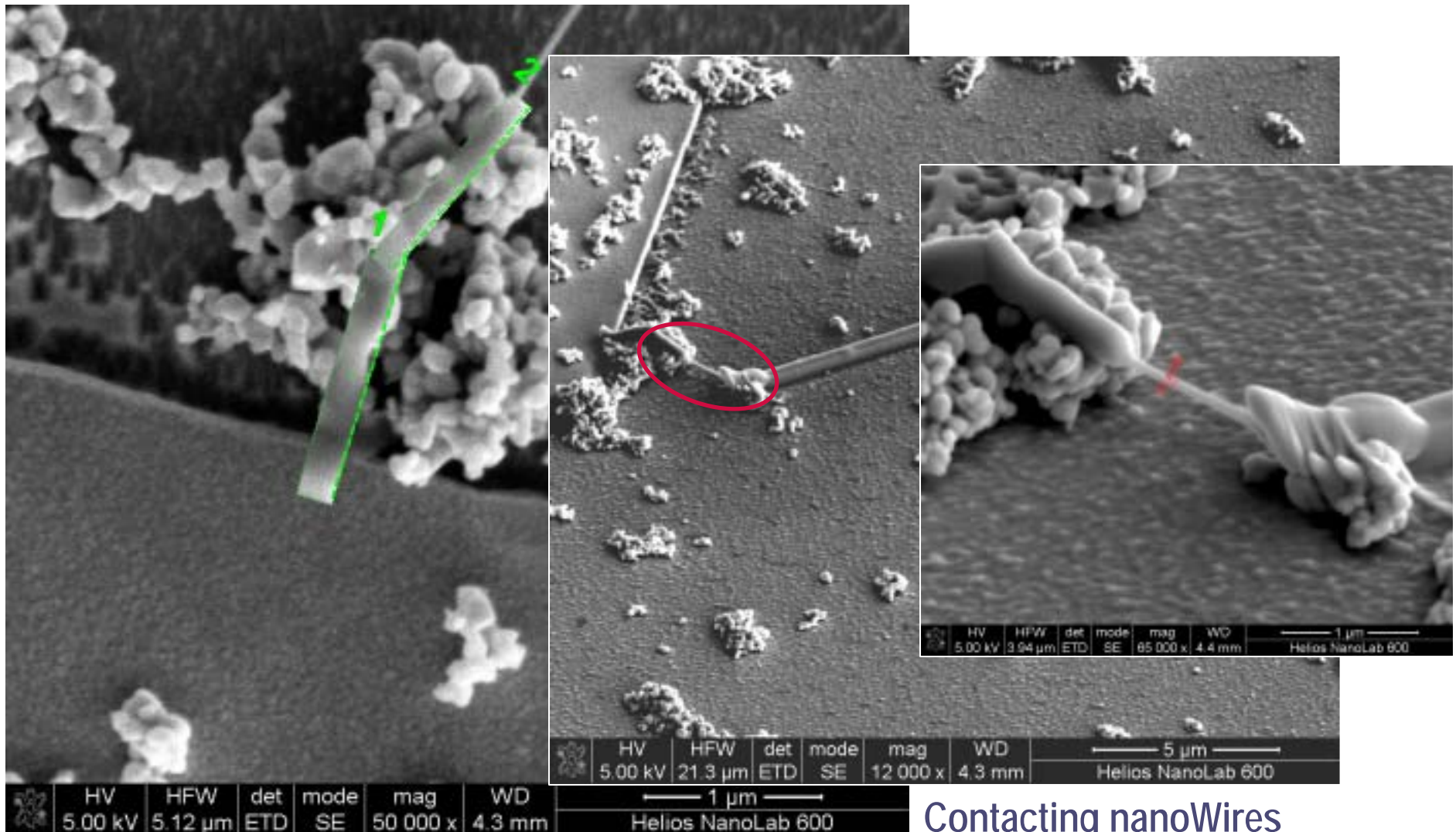
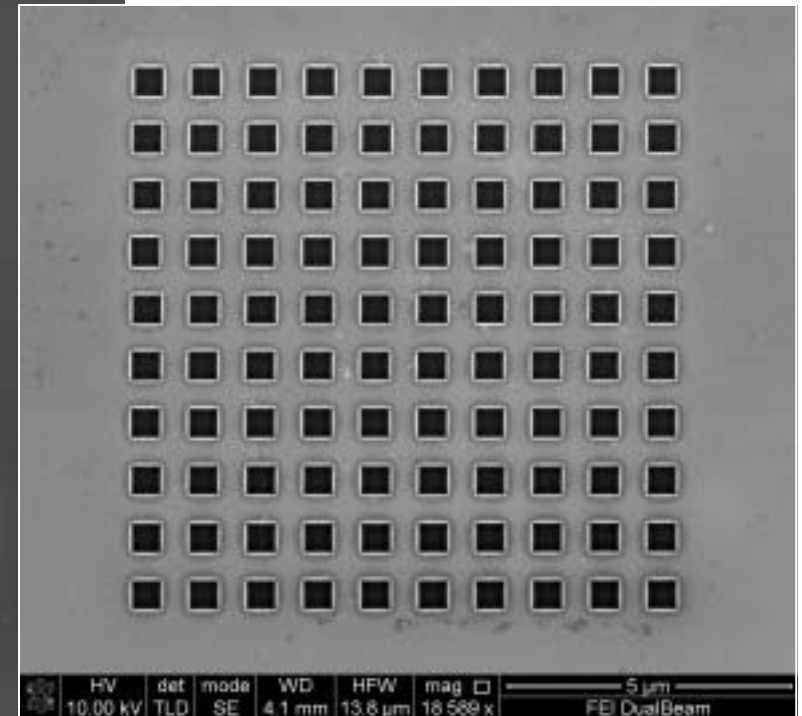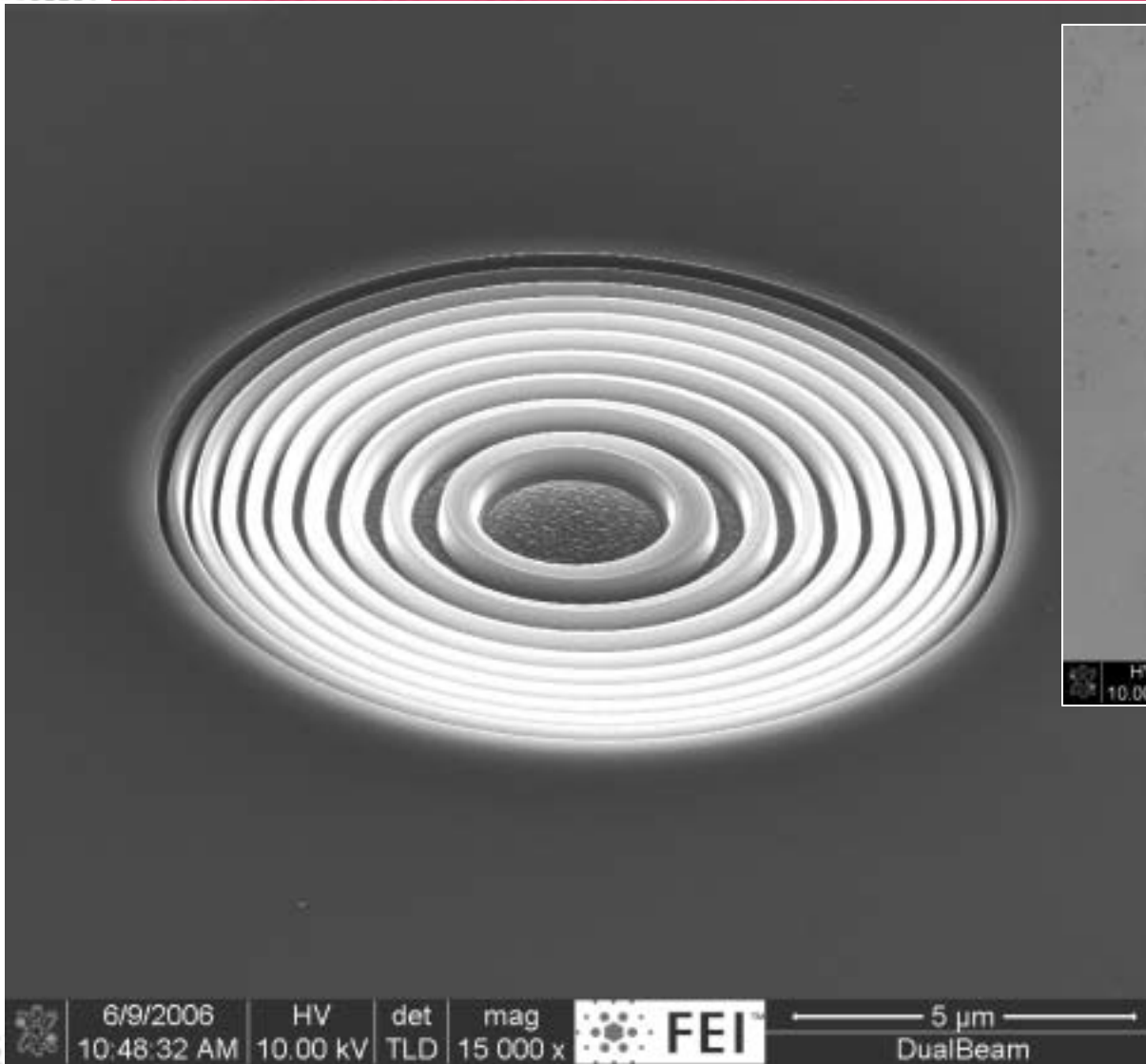
Contacting nanoWires
by EBID & IBID.

UI Patterns – Example: Array of Pillars

Circular Array of EBID
Pt Pillars
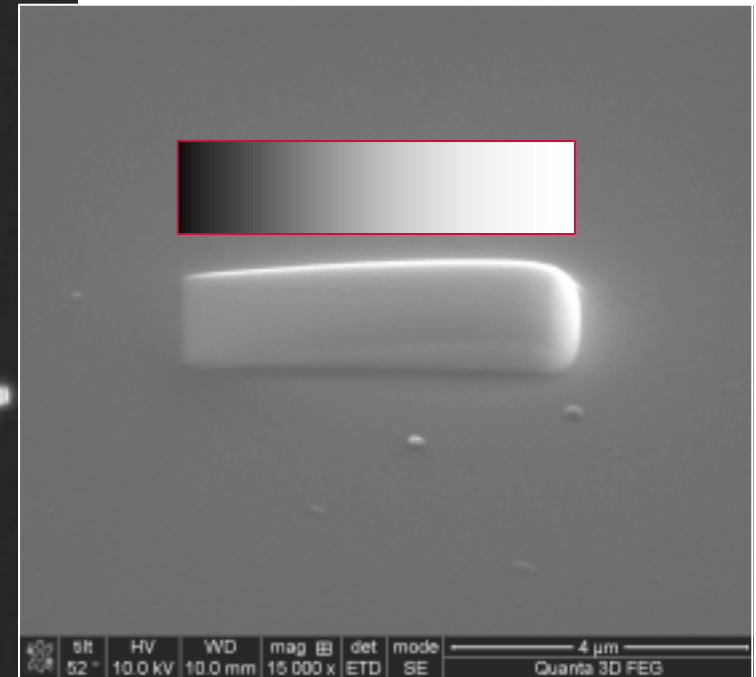
Scripting to Generate Patterns

Repetitive and parameterized patterns.

Alignment with fiducial recognition.

Automated control of stage, GIS, columns.

Bitmap Patterning – Examples

FEI Logo in PMMA (EBL).

3D Deposition with the FIB, dwell time ~ pixel brightness.

Conclusion

FIB is a great tool for NanoFabrication

- FIB Device Prototyping
- EBL Process Prototyping
- Process Characterization

There is more … !

- Simulation incl. influence of FIB trajectory, redep artifacts, …
- 3D Machining
- Applications (today and tomorrow) in Photonics, Micro-/nanoFluidics, MEMS/NEMS, …

FEI