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TESCAN ORSAY HOLDING EXCELLENCE IN SCIENTIFIC INSTRUMENTATION





**TESCAN ORSAY HOLDING** 



#### Rocking Stage Technology in a Plasma FIB-SEM: Overcome Curtaining Effects & More .....

- Due to lower current density of plasma FIB, there is inherently more curtaining
  Rocking stage mitigates the curtaining with a high precision piezo stage
- A pivot point created at any stage location ( \$20°)
  - Automated and integrated with cross-section and tomography work flows

### Rocking Stage to mitigate differential milling due to channeling

- Initial testing of the Rocking Stage to mitigate channeling effects is promising.
- This approach is also useful on larger areas.
- It is possible to augment RS milling with selective etching and homogenization recipes.



## **The Imaging Problem:** 14 nm Imaging – 1 Layer

Tech Node	Area	Tiles	Days	\$\$\$	seconds/Tile
14nm	100 um <sup>2</sup>	600	0.1	\$150.00	10
m=60,000x	1 mm <sup>2</sup>	60,000	6.9	\$15,000.00	10
	1 cm <sup>2</sup>	6,000,000	694.4	\$1,500,000.00	10
Tech Node	Area	Tiles	Days	\$\$\$	seconds/Tile
14nm	100 um <sup>2</sup>	600	0.0	\$15.00	1
m=60,000x	1 mm <sup>2</sup>	60,000	0.7	\$1,500.00	1
	1 cm <sup>2</sup>	6,000,000	69.4	\$150,000.00	1
Tech Node	Area	Tiles	Days	\$\$\$	seconds/Tile
14nm	100 um <sup>2</sup>	600	0.0	\$7.50	0.5
m=60,000x	1 mm <sup>2</sup>	60,000	0.3	\$750.00	0.5
	1 cm <sup>2</sup>	6,000,000	34.7	\$75,000.00	0.5

Slide courtesy of Michael Strizich (Adapted)



# **Device and Chip level RE**



Image Reconstruction Via Compressive Sensing



- Intel Skylake 140 n process (Faelayered to M0 on a Tescan Plasma FIB Simulated image of a) with 20% of the scan data (5X faster) a)
- b)
- rered imagency sing Bayesian Compressive Sensing C)

## **Selected References**

The potential for significantly reduce electron dose in high-resolution STEM images A Stevens, H Large, L Carin, I Arslan, ND Browning, Microscopy 63 (1), 41-51

Stable signal recovery from incomplete and inaccurate measurements EJ Candes, JK Romberg, T Tao - Communications on pure and applied mathematics, 2006

## This is <u>not</u> image processing!

- □ It is image reconstruction
  - Focal Series Reconstruction (TEM) Ceone and Thust
- Both compressive sensing and Point Spread Deconvolution hay be applied concurrently.





## **GENERAL DESCRIPTION OF MATERIALS CHARACTERIZATION**

Forward modeling starts from a model of the microstructure (as obtained, for instance, from a preliminary reconstruction in the serial sectioning case, or a simple filtered back projection) and computes what the images would look like if this primary result were the correct microstructure. Consideration of the differences between the predicted images/diffraction patterns and the experimental ones then allows one to construct an iterative algorithm to extract the best possible microstructure model, given an experimental data set and prior knowledge about the sample and the imaging modalities. *- Marc DeGraef* 



Generalized forward projector (physics-based)



# High level view of Dictionary Indexing





Comparison of Ga-FIB and Plasma-FIB image resolution depending on the probe current

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