“Stage Current” Monitoring and Endpointing in FIB

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FIB System Overview

VectraVision process module

Gas Box

Gas 1
Gas 2
Gas 3
Gas 4
Gas 5
Gas 6

Microscope

FIB chamber

Detector

GAE nozzles
Signals in FIB System

Biased Detector

Secondary Electrons

Secondary Ions

Dielectric

Silicon Substrate

Sample absorbed current detection
“Stage Current” in FIB System

Biased Detector

$I_{Se^-}$

$I_{S_i}$

$I_{lb}$

$I_{sample}$

Sample absorbed current detection

Silicon Substrate

Dielectric
Effective Sample Absorbed Current

On transition from dielectric to metal:

1. Effective Se$^-$ yield increases;

2. Effective Si$^+$ yield decreases.

Same effect on the sample current:

\[ I_{\text{sample}} = I_{lb} + I_{Se^-} - I_{si^+} \]
Sample Current Monitoring Approach

Sample

Chassis

Low Noise Triaxial Cable

Picoammeter

Digital Data Link

PC
Advanced Sample Current Monitoring

Sample -> Chassis

Preamplifier

Analog Data Link

Picoammeter

Digital Data Link

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Via Milling Endpoint:

A 0.5 µm by 0.5 µm via with 7 µm depth milled in backside edit sample by XeF2 GAE process and 5 pA beam current.

“Stage Current”

“Secondary Electron”
Dielectric Deposition Endpoint

A 1 µm by 1 µm and 2 µm deep via in Si filled with SiO₂ dielectric. Primary beam current ~ 6 pA.
A 0.4 µm by 0.4 µm and 5 µm deep via is filled with W conductor. Primary beam current ~ 5 pA.

Data is collected by the setup with in-vacuum preamplifier.
Conclusions

• Sample absorbed current signal includes information from all the charged particles, generated in FIB system during the milling and deposition processes.

• “Stage Current” endpointing of HAR via milling process is possible with good S/N ratio.

• Dielectric deposition endpointing for backside edit via fill is a unique capability provided by “Stage Current” endpoint detection.