What Gas Concentrator Does in Focused Ion Beam System?

Applicable to Focused Electron Beam Systems and Broad-Beam Apparatus

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Outline

- Gas pressure considerations
- Electron optics considerations
- Endpoint detection considerations
- References
CUPOLA Gas Concentrator

Main Chamber Volume with Pressure ~10E-6 Torr

Beam Pass

Processing Volume with mTorr Pressure

Gas Injection

Mirror - Polished Surface
Gas Pressure Considerations

- Pressure in low mTorr range within ~2 mm$^3$ process volume, optimal for GAE and deposition
  - Beam path in high pressure ambient minimized and scattering of the primary beam is reduced

- System chamber maintained at ~ 10E-6 Torr
  - Reduced damage to main chamber components by the reactive process gases
Electron Optics Considerations

Concentrator effectively transmits secondary electrons

0V bias – over 25% transmission
+200V bias ~ 98% transmission
Negligible effects on primary beam
Endpoint Detection Considerations

Extraction field penetrates through dielectric, aiding in endpoint, imaging

+ bias

SiO₂
Throughput Considerations

All contacts are 5µm deep

“Proof of Concept” test, milling small HAR vias with Beehive concentrator on FEI Vectra 986+ system
Summary

- Positively-biased gas concentrator in particle beam processing tool improves:
  - Gas pressure regime
  - Imaging concurrent with processing
  - Endpoint detection
  - Enhances milling throughput
References

- V. Ray “Virtual process chamber…..” EIPBN 2004 and JVST B 2004
- V. Ray “High-throughput HAR via milling” EFUG and ISTFA 2005
- C. Rue et. al. “Backside circuit edit on full thickness Si devices” ISTFA 2008