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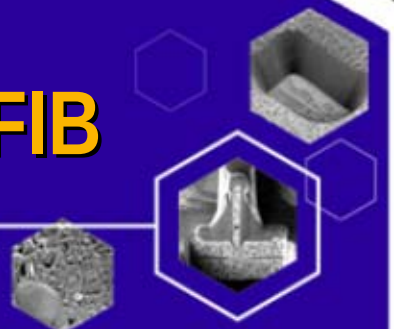
Circuit Edit
Imaging and Endpoint Beyond 130 nm

Valery Ray & Nicholas Antoniou

Development Directions for Circuit Edit FIB



- Image signal collection efficiency
- Ion beam placement accuracy
- High Aspect Ratio VIA milling
- Endpoint detection
- New materials

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Signal collection efficiency, Se^-

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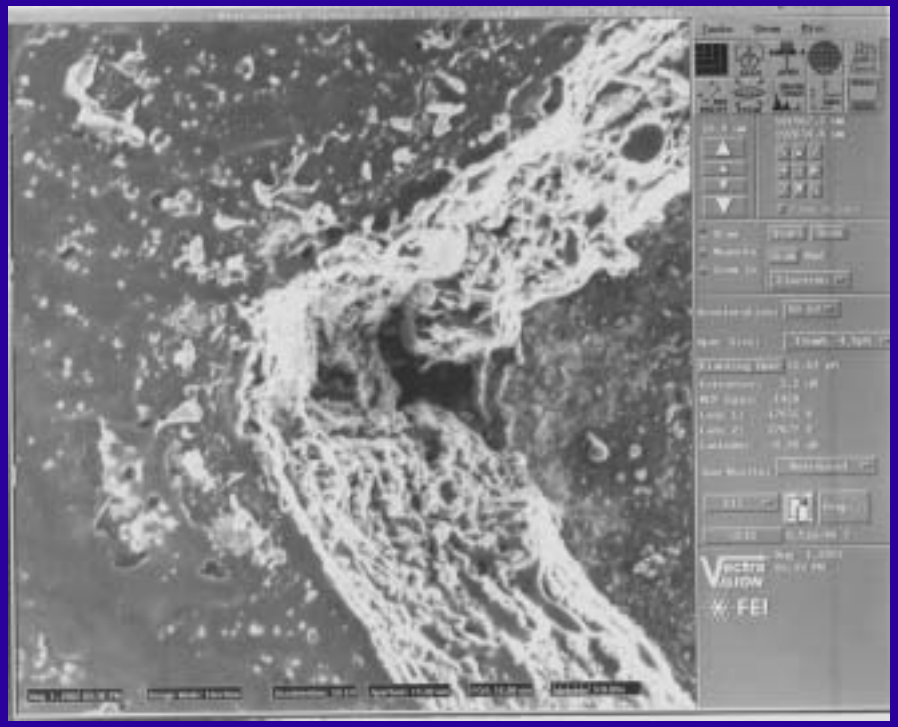
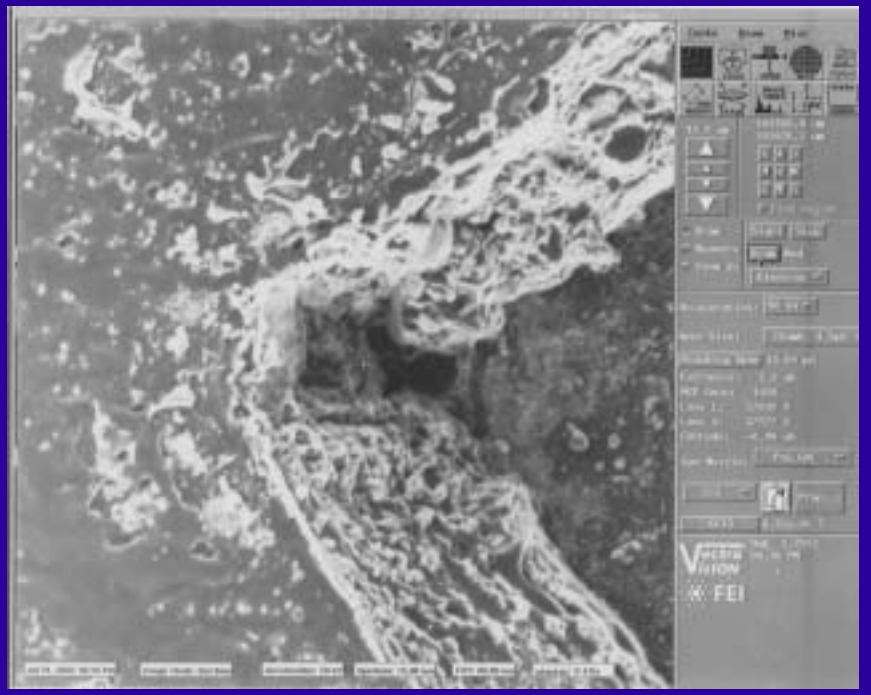


Retracted GAE nozzle

Extended GAE nozzle



Signal collection efficiency, Se-

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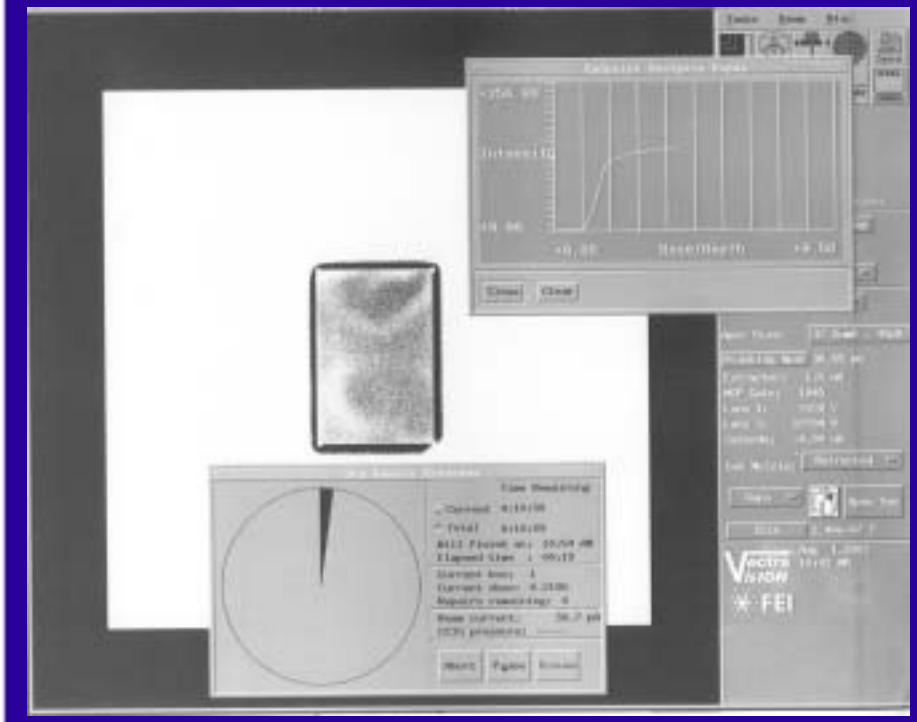
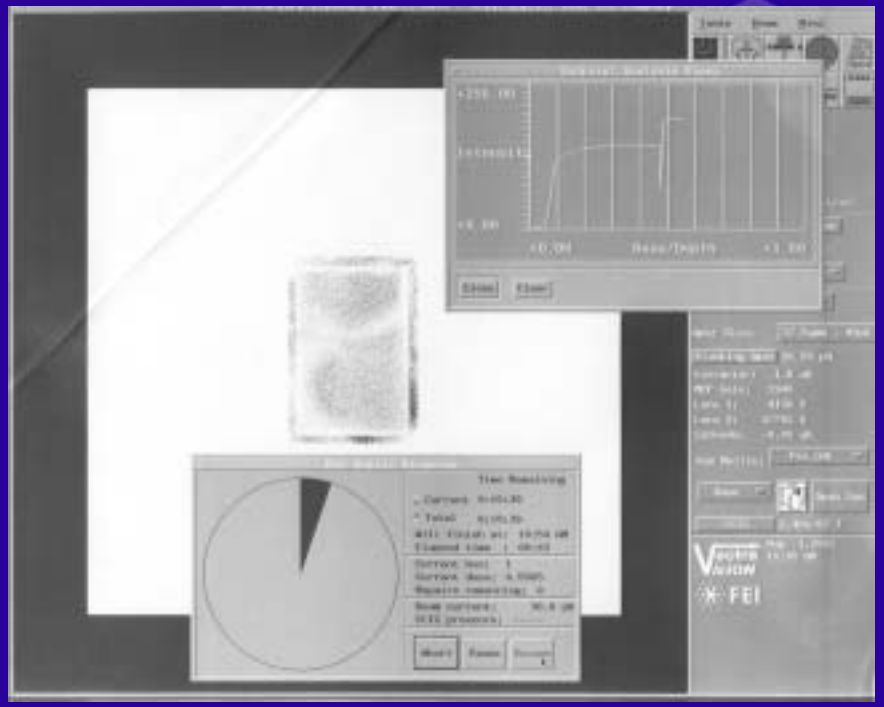


VIA milling, standard collection

VIA milling, improved collection



Beam Placement Accuracy, High Aspect Ratio VIAs

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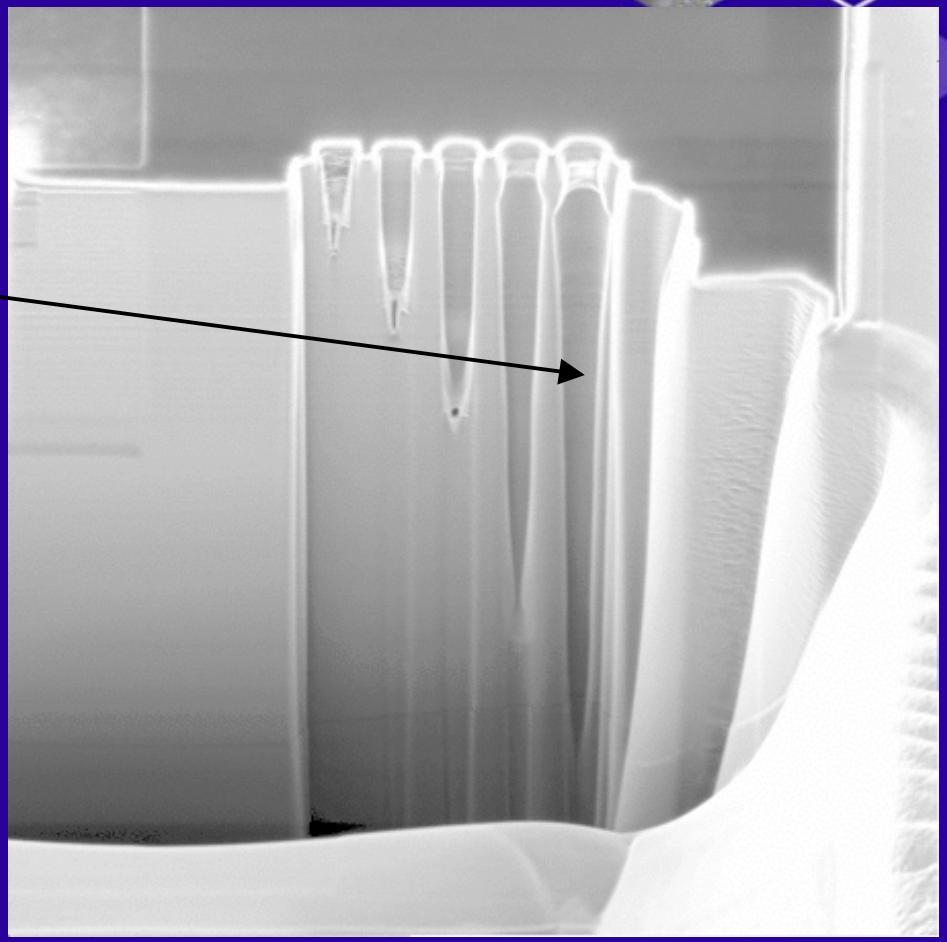
40:1 aspect ratio

FOV 15um, tilt 30 degrees



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HAR VIA Endpoint Detection

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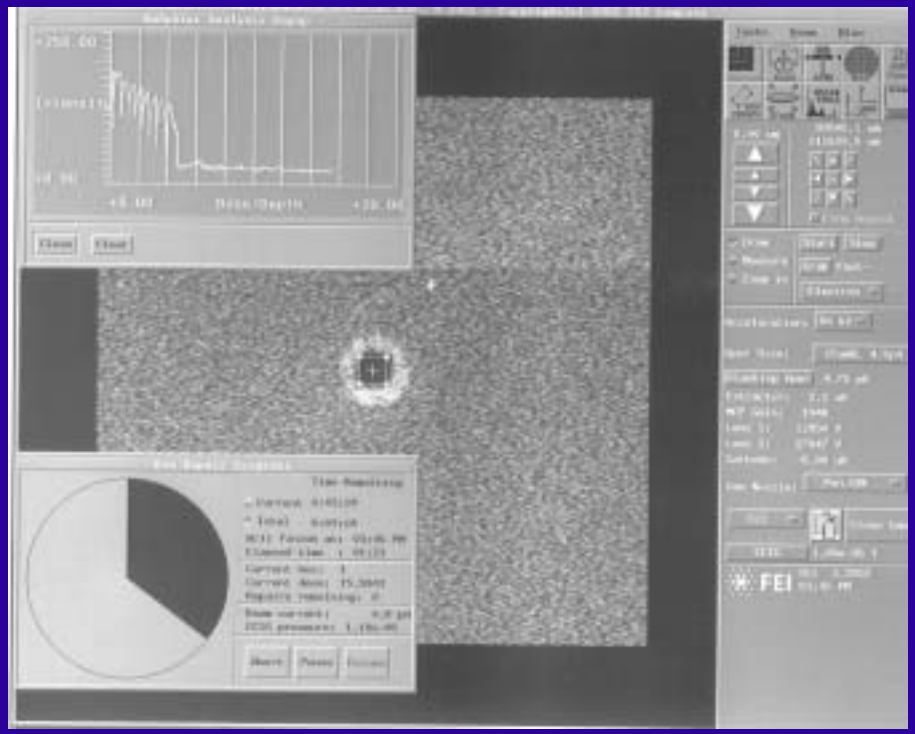

Stage Current
Endpoint in Metal

0.25um VIA milled through
5um dielectric to metal
20:1 aspect ratio with
reliable endpoint detection

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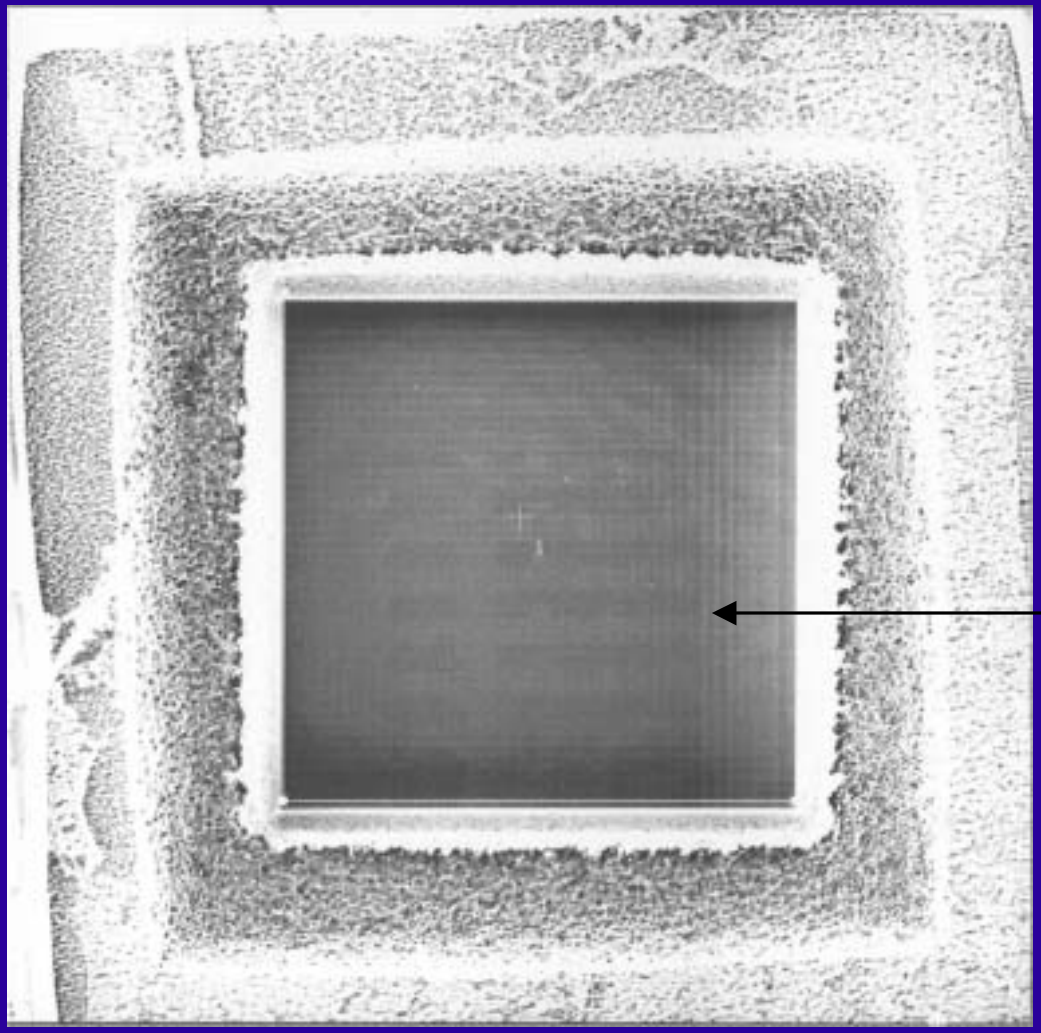
Si trench Endpoint Detection.



- OBIC endpoint is reliably used
- Charge contrast endpoint also shown

Matrix of 0.5 μm High Aspect Ratio Mills

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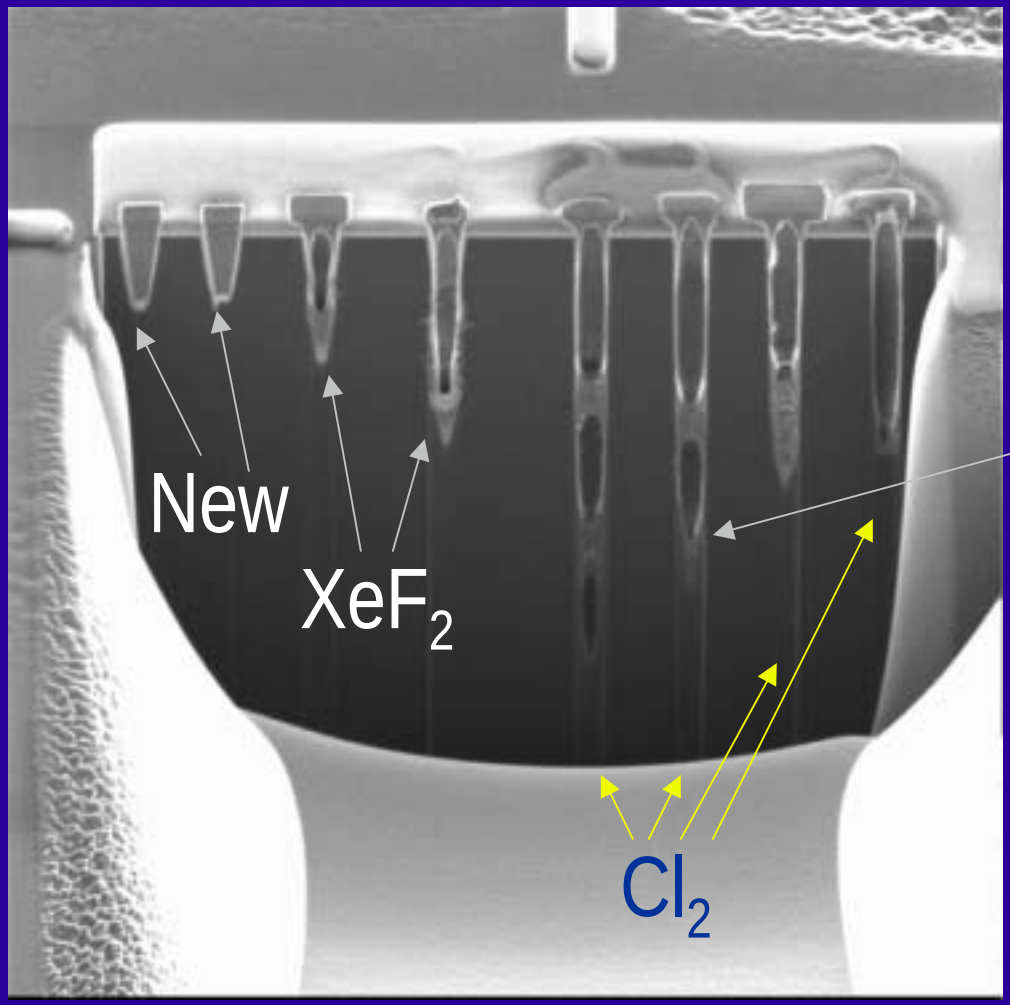

Cl_2 of 30:1 A/R

XeF_2 of 17:1 A/R

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Copper Interconnect and FIB

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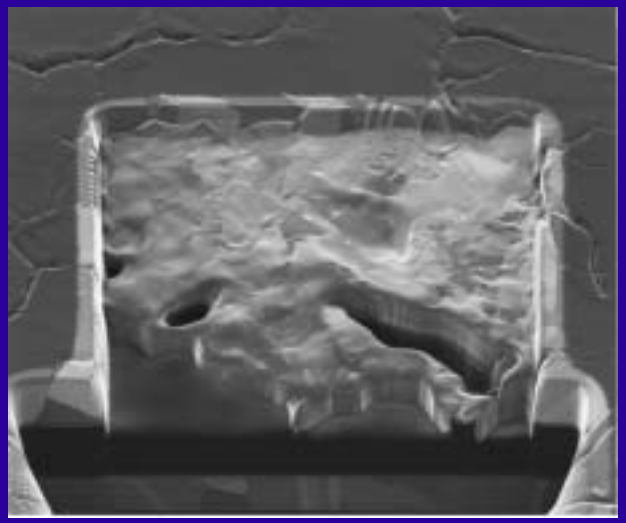
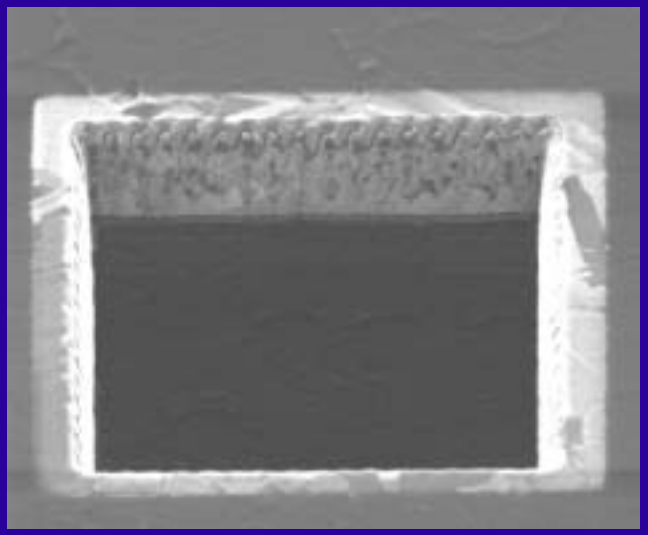


Straight sputter with FIB



CoppeRx

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CoppeRx Capability

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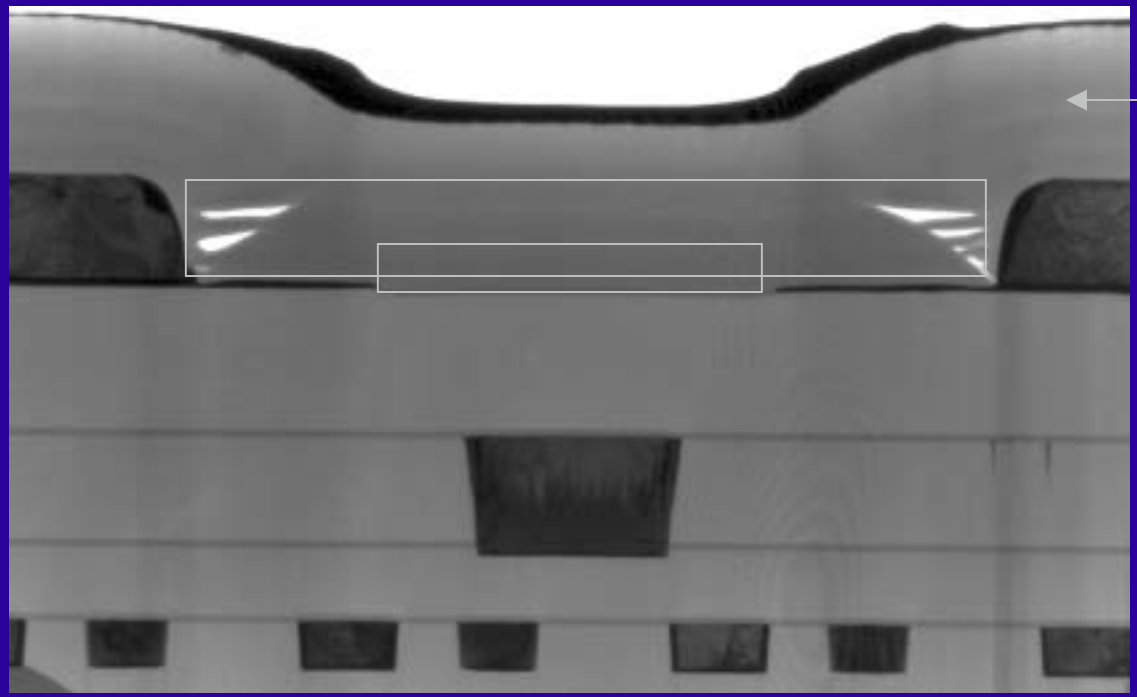
TEM Image of copper removal with end point on dielectric (middle) and liner on edges



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Advanced materials

- Low-k Dielectrics
  - » Carbon Doped Oxides
    - – XeF_2 provides enhancement and control
  - » Organic material ?
- Filler layers
  - » New challenges

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Conclusion

- Sub 130 nm circuit edit requires the following
  - Very high aspect ratio VIA milling (> 20:1)
  - Ultra sensitive endpoint techniques
  - Backside editing
  - Copper and low-k dielectric milling

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