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A new method to reduce artefacts during TEM sample preparation using FIB

EFUG 2006 - Wuppertal

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Failure Analysis

A new method to reduce artefacts during TEM sample preparation

- Motivation
- Amorphization
- Curtaining effect
- Optimized sample preparation
- TEM Imaging
- Conclusion

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Motivation

- Quality of the sample essential for high resolution TEM imaging

- FIB induced preparation artefacts like
  - Amorphization
  - Curtaining effects

  have to be reduced

⇒ Demand for an optimized TEM sample preparation

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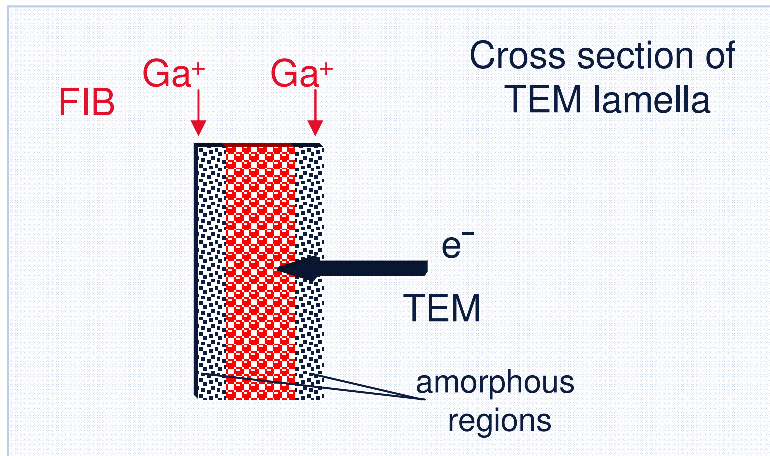
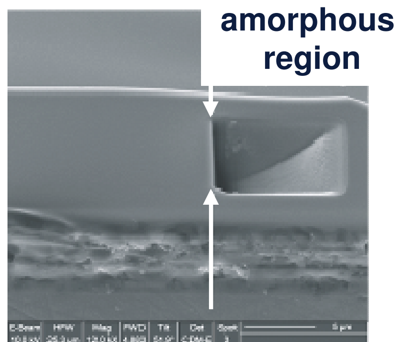
Amorphization

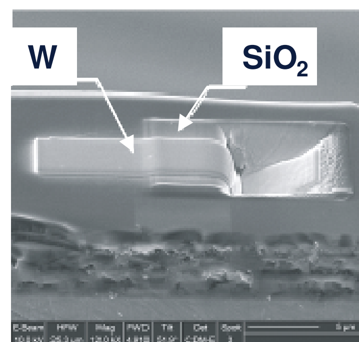
- Low kV thinning to reduce amorphous layers



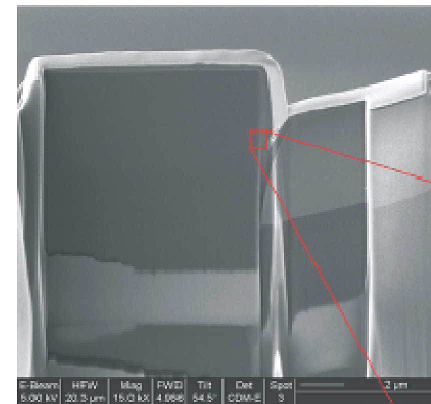
Procedure of sample preparation:



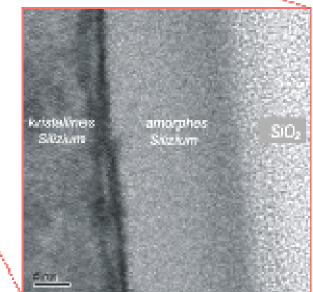
Ga^+ ion implantation :
30 kV 5 kV



Electron induced SiO_2 deposition and ion induced W deposition



Cross section of thinned lamella



HR TEM image

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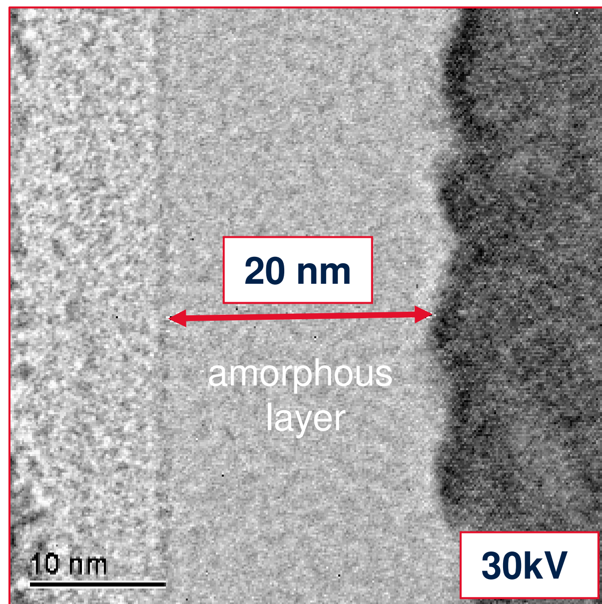
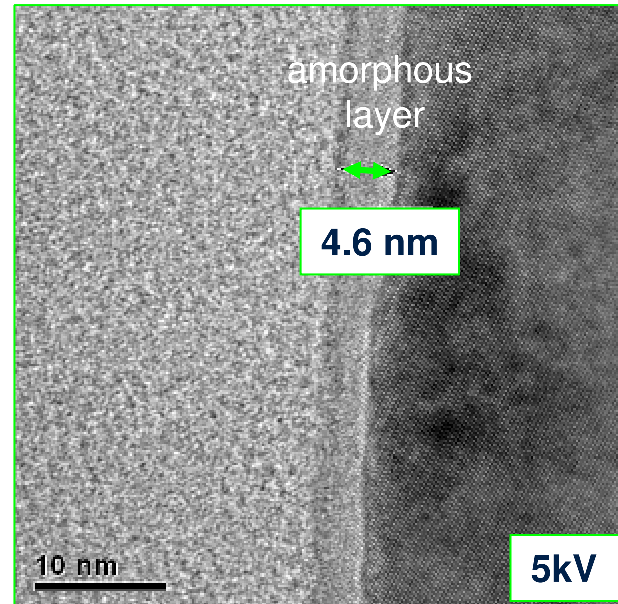
Amorphization

- Low kV thinning to reduce amorphous layers



Conventional TEM, not suitable for High Resolution (HR)



Good for HR imaging

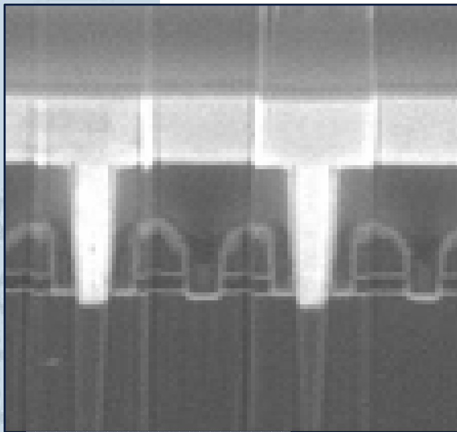
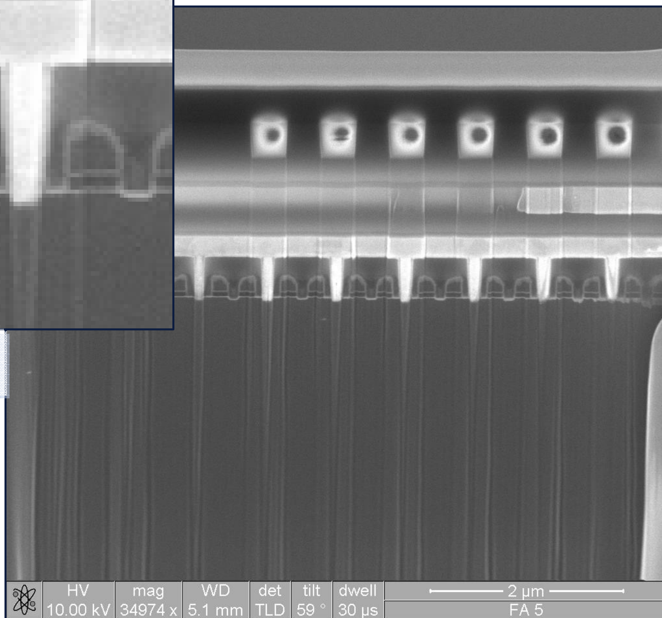
good results with low kV
20nm 4.6nm

Drawback: strong curtaining effects during low kV thinning

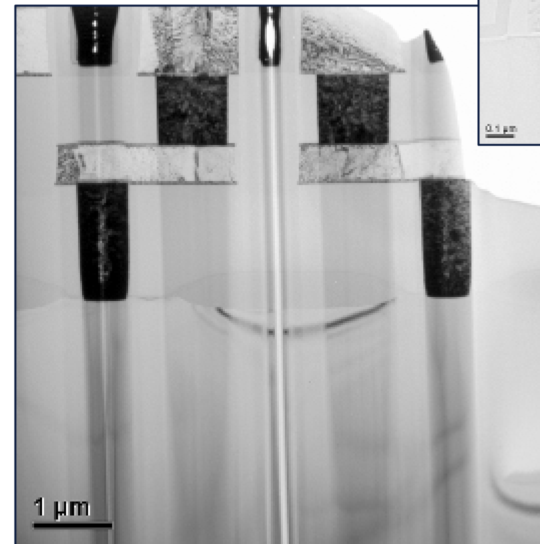
Curtaining

- Strong curtaining effect using low kV
  - caused by different material and sputter rates

➡ interfering variations in sample thickness

SEM Images



TEM Images

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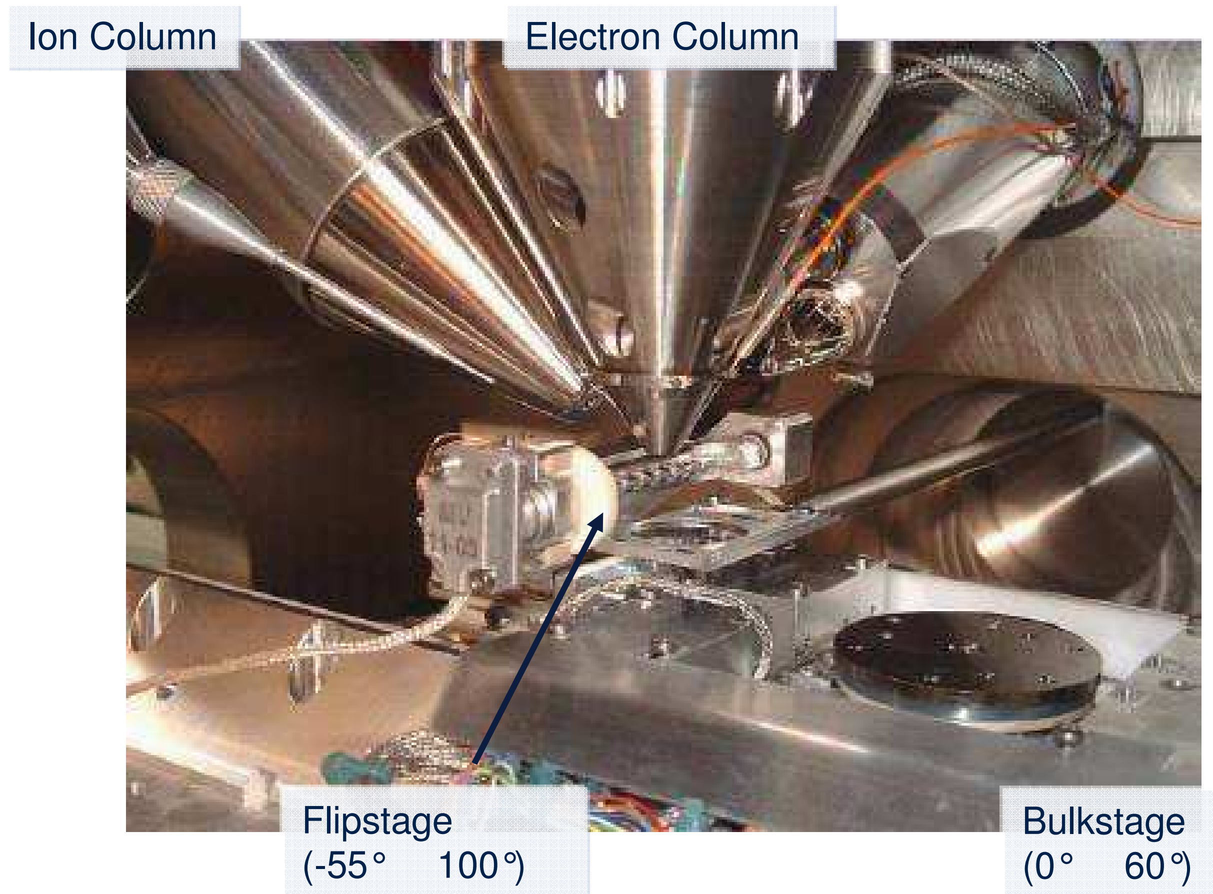
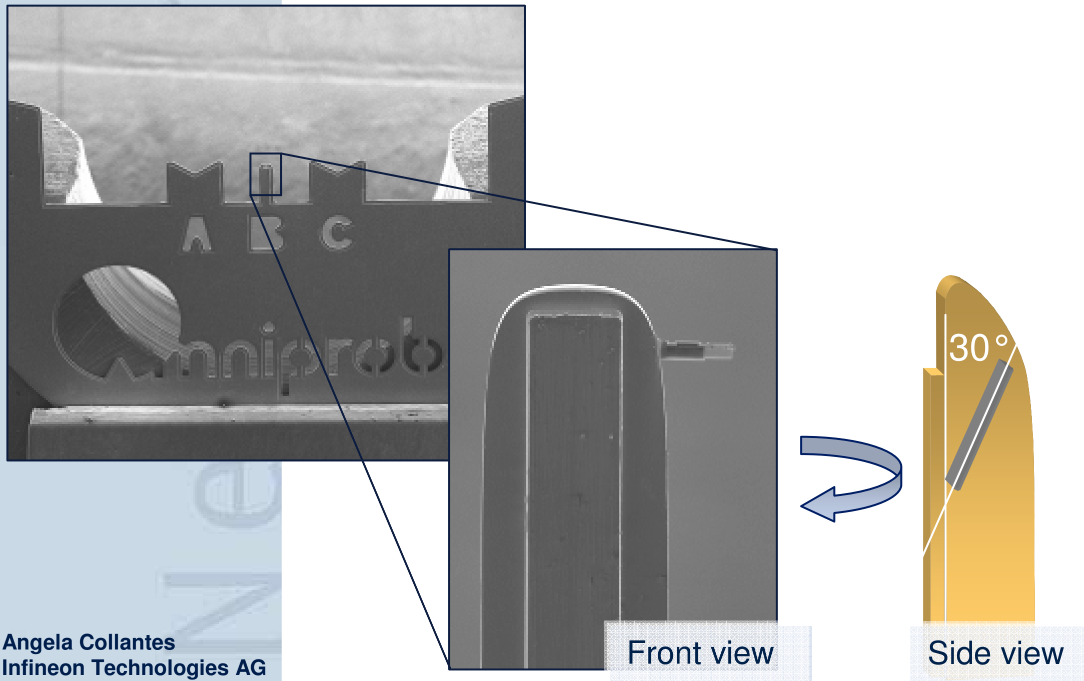
Optimized TEM sample preparation

- Geometry of stages

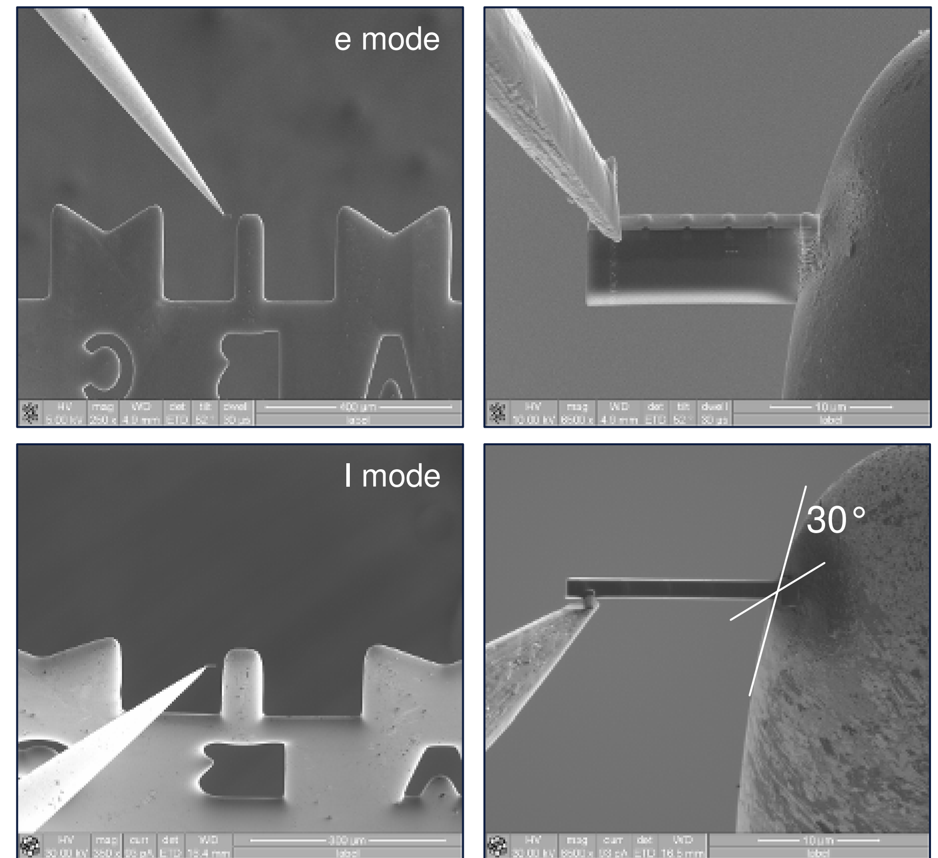


Optimized TEM sample preparation

- Lift Out:
  - Attaching of lamella to grid at 30°
  - Bulkstage = 52°
  - Flipstage = -30°



Grid with TEM lamella



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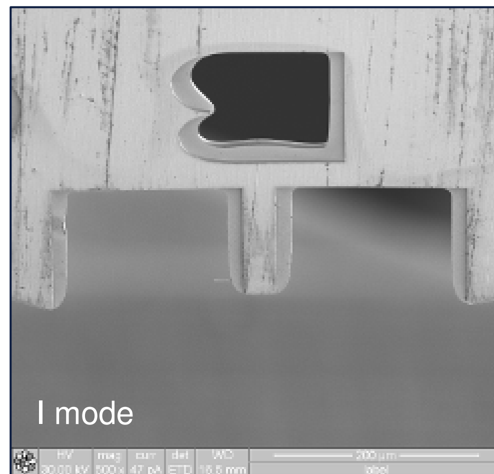
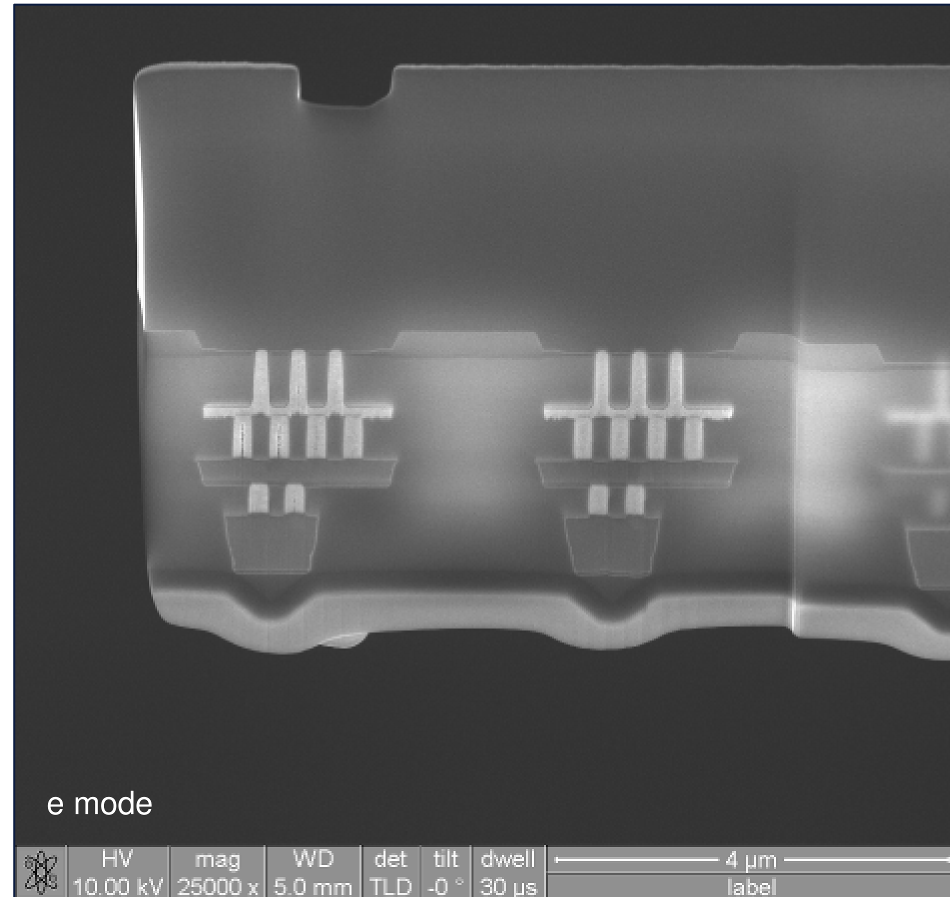
Optimized TEM sample Preparation

- Final thinning :
  - at 5kV to minimize Ga^+ implant
  - upside down to avoid curtaining

  - Bulkstage = 0°
  - Flipstage = 98°





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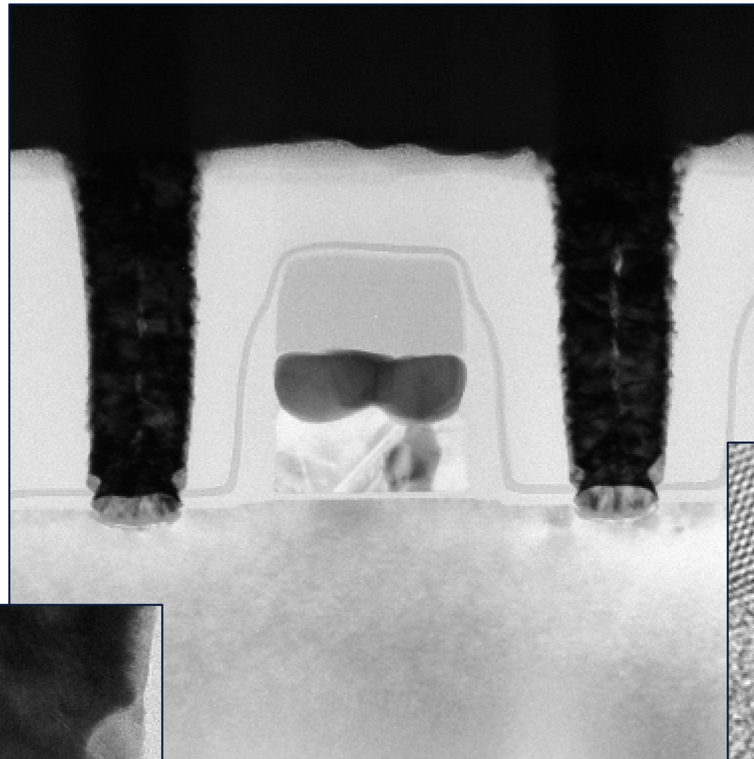
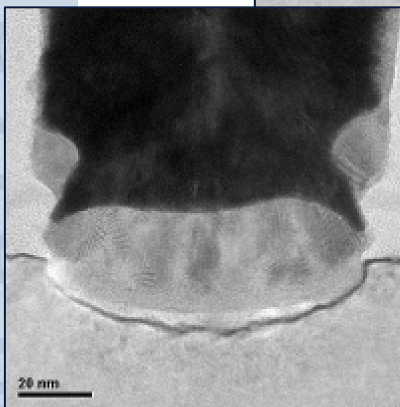
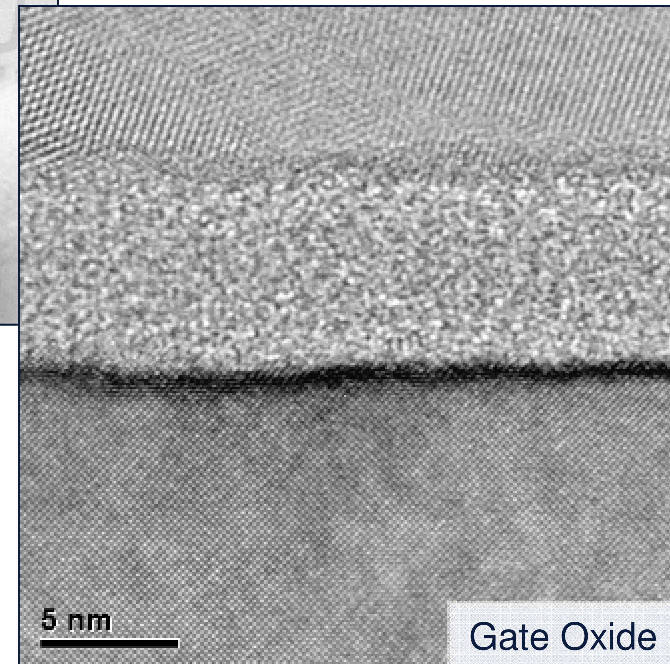
TEM Imaging





Good results with low kV and thinning from backside

reduced amorphization
no curtaining



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Conclusion

- A new method of TEM sample preparation was found
- Preparation artefacts such as FIB induced damage and curtaining effects were minimized
- Whole procedure is performed inside the FIB without additional handling of the sample
- Same time effort as for conventional preparation

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