Gallium Artefacts on FIB-milled Silicon Samples

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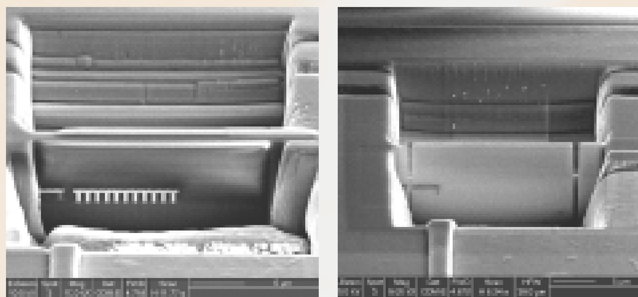
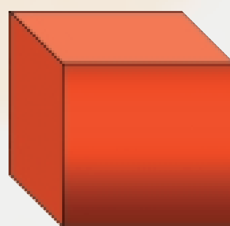
Purpose

The Focused Ion Beam Machine (FIB) allows sample milling on the sub-micrometer scale by local sputtering. Here, for the case of silicon semiconductor sample preparation, two kinds of re-deposition artefacts are analysed, which can be disturbing particularly in failure analysis applications.

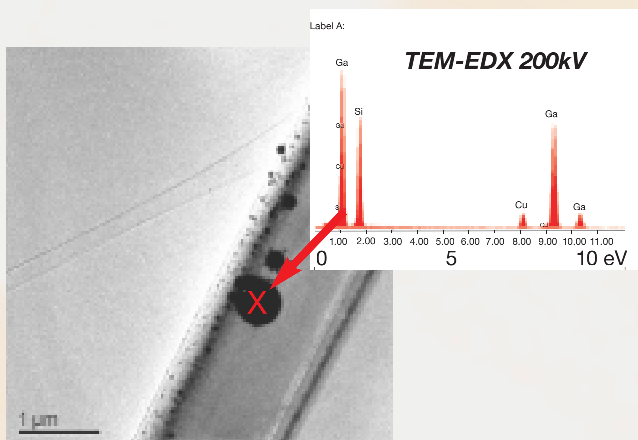
Analysis of Artefacts



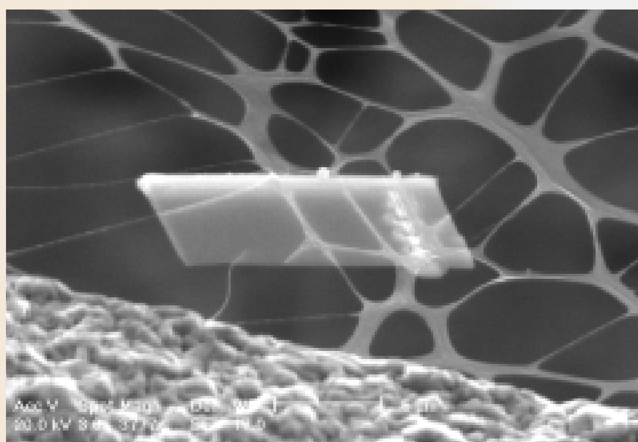


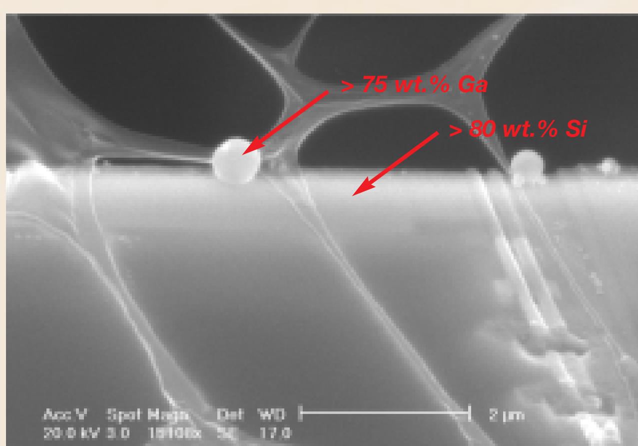
amount of Ga for 1 lamella:
30 min, 20 nA
~ 2.55 • 10^{-8} g Ga
~ 4400 µm^3
~ (16.4 µm)^3

TEM lamella preparation by FIB



TEM bright-field image with preparation artefacts
EDX spectrum of large artefact





Sample lamella on TEM carrier (SEM, EDX) with Ga droplets

Experiments

Experiment 1: Ga-Beam-Induced Re-Deposition

sputtered material: ← *Ga beam scan area*

10°

+ 300 pA 60 sec
+ 3000 pA 60 sec
+ 3000 pA 60 sec
+ 3000 pA 60 sec

Results:
1. **A closed film re-deposition appears, expected to consist mainly of silicon.**
2. **Ga droplets form.**

Experiment 2: Prevention of Re-Deposition

sputtered material: ←

SEM observation

Ga beam scan area

3. no visible re-deposition

Result:
3. **No re-deposition is observed in the shade.**

Summary

- Two kinds of re-deposition: film & droplets.
- Preparation artefact «Droplets» consist of > 75 wt.% Ga. Such Ga droplets may mislead in failure analysis.
- Re-deposition is induced by the Ga-beam.
- Re-deposition prevention by keeping point of interest in the shade.

Acknowledgement
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