Eufanet workshop on 3D imaging techniques for ICs

Date: Wednesday October 6th between 17:30-19:15
Location: At the ESREF conference (October 5-8th)
Number of attendees: 32

Speakers

- Joachim Reiner (EMPA)
- Thomas Schweinboeck (Infineon)
- Francis Morrissey (FEI Company)
- Roland Schmidt (Hitachi)

Program

Introduction / Eufanet (Philippe Perdu)

What is Eufanet and its purpose to support a European network of people related to failure analysis.

Legal Status (Christian Boit)

With founding, there are more opportunities to improve Eufanet (eg Website quality, Workshops).

1. TEM analysis of gate oxide breakdown damage (Joachim Reiner)
2. 3-D TEM Tomography - An Evaluation of a Commercially Available System (Thomas Schweinboeck)
3. In-situ sample preparation and high-resolution SEM-STEM analysis (Francis Morrissey)
4. 3D (360degree) failure characterization in semiconductor devices using Hitachi's FIB/STEM system FB-2100/HD-2300 (Roland Schmidt)

Discussions

(see summary bellow)

Summary

3D imaging techniques at high resolution linked to TEM and STEM. Where STEM is Scanning Transmission Microscopy.

	3D imaging, what we want	**3D imaging, what we can**
Material contrast		1 nm
Electron diffraction contrast	Poly-Si	Poly-Si not possible Poly lost due to sample tilting
Resolution	< 1 nm (2D) Good resolution in 3D too	< 10 nm (toward 1 nm) Crystalline Si, when aligned very good resolution can be obtained. In 3D it is another story and such resolution is not possible: 3D resolution is an issue -Resolution depends of element weight (eg Ti)
Allowed sample slide		2 x 4 µm
Preparation time		< 1 hour (DB FIB-STEM)
Speed, effort and	Manufacturer to offer service:	FEI has 2 service labs in Europe

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cost(€)	Service lab (experienced users) at a reasonable cost	Hitachi has 1 service lab in Japan

Key points and questions

This second Eufanet workshop was targeted to high resolution TEM and STEM techniques to locate very small defects and possibly latent defects in 3D.

Tools suppliers presented mature 2D solutions. 3D imaging is possible but resolution has to be improved to meet users' requirements.

TEM experienced user (B. Domingues – Philips) said that there are some physical limits that must be taken into account such as element weight: Imaging of heavy elements and light elements is quite different and high resolution 2D crystal imaging does not appear as straightforward in 3D (much lower resolution).

A last important topics brought up by P. Jacob (EMPA) was for tool cost and required experience to use them. Since these tools are not routinely used (excepts maybe for I manufacturer), there is a requirement for service lab access in Europe for labs which are not equipped and will not due to the excessive cost of tool, maintenance, and needed human resources.

Finally, a question from J. Reiner to investigate latent defects in gate oxides may be answered by AFM based techniques, especially TUNA, tunneling AFM which is used to characterize oxide quality and leakage. TUNA may have been used to located (2D) latent defects in gate oxides.

Conclusion

STEM has shown very good 2D contrast images. But, seeing this contrast in 3D would definitely help the analysis. However, the answer is not only technical but also economical. A viable solution for several labs in Europe could be to access 3D imaging tools through service labs.

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