Status And Trends In 3D Nanodevices: Inspection By Electron Tomography

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ABSTRACT

The reduction of the size of modern semiconductor devices has lead to the requirement of characterisation techniques with nanometer resolution, and more recently these requirements have been extended to all three dimensions. Most classical characterisation methods provide only 2-dimensional projections and are therefore unable to reproduce the complex structure of 3D nanoelectronic devices. To perform 3D nanocharacterization, electron tomography must be implemented. In electron tomography, a sample illuminated by an electron beam is tilted while a series of TEM images are recorded. The images are then used as an input for 3D reconstruction algorithms. The process leads to a 3D image of the nanodevice with a depth-resolution almost equal to the lateral resolution.

The spatial resolution can reach few nanometers for a sample with a cross-section as large as 200nm. These dimensions correspond well to the needs of the nanoelectronics industry which makes electron tomography an ideal method for advanced device characterization. For crystalline samples High-Angle Annular Dark Field Scanning TEM (HAADF STEM) is especially well suited for image acquisition since the diffraction contrast becomes negligible. Therefore the projection requirement is fulfilled and 3D reconstruction algorithms can be used. HAADF STEM can provide chemical contrast as the signal of the projections is proportional to the mass-thickness product [1].

In this study we present the technique of electron tomography and discuss advantages and limitations. We report some recent HAADF STEM results for the characterization of nanowires and nanowire-based devices. In particular tomography allows the characterization of interface morphology in three dimensions which is frequently a critical parameter for device performance. The potential of energy-filtered TEM (EFTEM) tomography for quantitative chemical imaging of nanodevices is also highlighted [2].

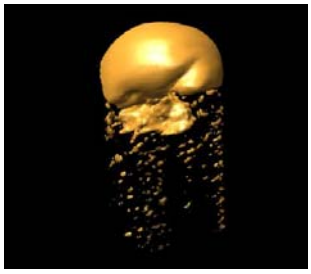

FIGURE 1. 3D reconstruction of gold catalyst particle on a silicon nanowire.

REFERENCES

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2. N.Y. Jin-Phillipp et al., *Microsc. Microanal.* **16**, 1842-3 (2010).

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