Nano X-Ray Tomography using Synchrotron Radiation and in the Lab: Applications in Nanoelectronics

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The availability of high-brilliance X-ray sources, high-precision X-ray focusing optics and very efficient CCD area detectors have contributed essentially to the development of transmission X-ray microscopy (TXM) and X-ray computed tomography (XCT) with sub-100 nm resolution. Particularly, the fabrication of high aspect ratio Fresnel zone plates with nearly theoretical diffraction efficiency has contributed to the enormous improvement in spatial resolution during the previous years [1]. Currently, Fresnel zone plates give the ability to reach spatial resolutions of 10 to 20 nm in the soft and of about 30 to 100 nm in the hard X-ray energy range.

Synchrotron radiation experiments have been used to study new processes and materials that have to be introduced into semiconductor industry. The potential of TXM using synchrotron radiation in the soft X-ray energy range has been shown for the nondestructive in-situ imaging of void evolution in embedded on-chip copper interconnect structures during electromigration and stress migration [2,3].

X-ray microscopes with rotating anode X-ray sources that can be installed in an analytical are available on the market [4]. This unique TXM/XCT possibility provides new perspectives for its application to failure localization in micro- and nanoelectronic structures and products, e. g. to the visualization of voids and residuals in metal 3D Through Silicon Vias (TSV) for 3D IC integration. It is an essential advantage of TXM and XCT in the hard X-ray energy range against other currently used techniques that failures or defects can be localized without physical modification of the region of interest.

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