A 60nm-tomography by transmission hard x-ray microscope

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An energy-tunable transmission hard X-ray[1-3] microscope with close to 60-nm spatial resolution in three dimensional has been developed.[4] This x-ray microscope is operated at 8-11 keV which is sourced by the super conducting wavelength shifter (SWLS)[5] installed at BL01B in NSRRC. This microscope utilize capillary-based condenser which has higher efficiency than the zoneplate condenser, furthermore, providing a large numerical aperture which matches numerical aperture of the higher order image of zoneplate [6].

With the hollow cone beam generated by this capillary-based condenser, the zoneplate of 50-nm outmost zone width, stable mechanical design and software feedback, we obtained the tomographic data sets which are close to 60nm spatial resolution. Meanwhile, the element specific imaging was also obtained by a differential absorption contrast technique using taken below and above absorption edge of the specific element.

Intergraded circuit (IC) devices are used to demonstrate the element selectivity and spatial resolution in 3D of the microscope. The tungsten plug, which is the interconnection in the IC, has the defects inside the plug which so call the “key hole”. The size is from several nanometers to sub-micron. In the pass, this kind of defect was impossible to visualize nondestructively and usually took several days to make the proper sample for transmission electron microscope (TEM). With this microscopy, we are able to do a single projection about 15 seconds and a complete tomography with limited angle in several hours. The resolution of tomography is estimated about 60nm in 3D. The tomogram is shown as figure 1.

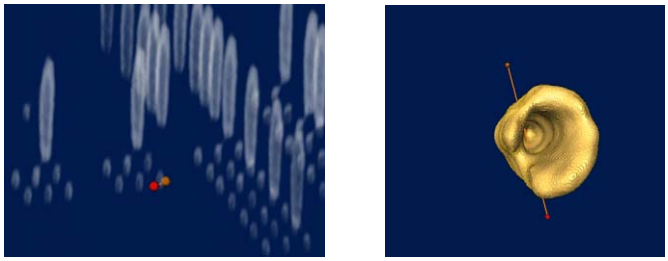

Figure 1 (left) The 3D rendering of the tomogram of tungsten plug. (right) The magnified tungsten plug is shown in isosurface mode, and length of the orange strip is 300nm.

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