Xradia's nano-XFI X-ray Fluorescence Imager for High Resolution Elemental Mapping

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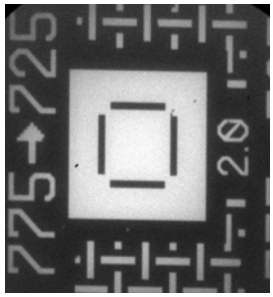
We present a novel approach to map characteristic x-ray fluorescence using an x-ray camera that can image selectively different x-ray energies. The camera employs a Fresnel zone plate as the x-ray imaging optic and achieves currently sub-100nm spatial resolution, ultimately limited by the quality of zone plates available. The camera can be used with electron or x-ray excitation beams and therefore is suitable for attachments to standard scanning electron microscope (SEM) instruments as well as synchrotron-based experimental end stations.

The advantages of this camera compared to traditional energy dispersive (EDS) or wavelength dispersive (WDS) mapping techniques are that the spatial resolution is not limited by the excitation spot, that a whole map of one element is collected simultaneously in a full-field image, that the spatial resolution does not degrade with sampling depth, and that the method has high efficiency and energy resolution for sub-2kV radiation. The imaging is also insensitivite to sample charging experienced with the SEM, and has the ability to perform thin film measurements on small patterned structures.

The X-ray fluorescence imager can be used for both x-ray and electron beam excitation. For example, it can easily be integrated into an existing scanning electron microscope, in a similar way to EDS and WDS equipment.

In contrast to EDS/WDS mapping, it is preferred for the x-ray fluorescence camera to excite a larger spot on the sample corresponding to the field of view of the fluorescence map. High spatial resolution is achieved by directly imaging the fluorescence x-rays on an array detector (CCD), rather than compiling a map by varying the position of the excitation spot. The high spatial resolution of the x-ray imaging camera is also preserved with sampling depth, enabling high-resolution x-ray maps of buried structures and recovery of 3-d information. Since a whole map is collected simultaneously, x-ray fluorescence maps can be collected in a short amount of time compared to WDS/EDS maps.



X-ray fluorescence maps of backend copper integrated circuits are presented as an example of non-destructive imaging of sub-surface structures. The x-ray fluorescence camera enables the in-situ location of voids and defects in backend copper ICs without physical deprocessing or ion beam milling preparation and can be performed on whole silicon wafers.

Left: nano-XFI image of a copper IC sample. The shown field of view is approximately 70x90um in size.