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LATERAL DISTRIBUTION OF ELEMENTS IN THE MULTIELEMENTAL STANDARD SAMPLES STUDIED BY THE SYNCHROTRON RADIATION BASED MICRO X-RAY FLUORESCENCE

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Total-reflection X-ray fluorescence (TXRF) [1] is commonly employed in the semiconductor industry for determination of contaminants on silicon wafer surfaces. Similarly, the grazing emission X-ray fluorescence (GEXRF) [2] combined with synchrotron radiation and high-resolution detection of the fluorescence photons has proven to be successful to determine the concentration of low-level impurities on silicon [3, 4]. These techniques provide quantitative results and the calibration procedure normally used involves placing a micro-droplet (~µl) of the standard solution onto a silicon wafer. After evaporation of the solvent, the residual amount of elements on the wafer is used as a reference standard [1,3,4]. However, a distribution of residue material on the substrate surface is not known accurately and consequently, such calibration method is burdened with uncertainty as to whether the standard sample is of the pure particulate type, which is usually assumed for evaluation purposes, or whether forms a film-type layer.

In the present work the investigation of the lateral distribution of elements in the multielemental calibrating samples by using the synchrotron radiation based micro x-ray fluorescence is presented. The goal of this project was the investigation of a uniformity of the elemental distributions and determination of the droplet morphology. The studies have been performed at the European Synchrotron Radiation Facility (ESRF) at the ID21 X-ray microscopy beamline.

In the experiment the multielemental standard solution was deposited as a droplet (0.5 µl) on the silicon wafers and dried in oven in temperatures ranging from 20°C to 200°C. After evaporation of the solvent, the residual amount of elements on the wafer were analysed by the micro-XRF. The photon beam (energy 7.2 keV, flux ~10^9 photons/s) was focused using Fresnel zone plate to the size 0.7 µm × 0.3 µm. The full fluorescence spectrum was recorded (HpGe detector) for each pixel of the map. The X-ray 2D-images were next compared with the optical and the scanning electron microscope images (Fig. 1).

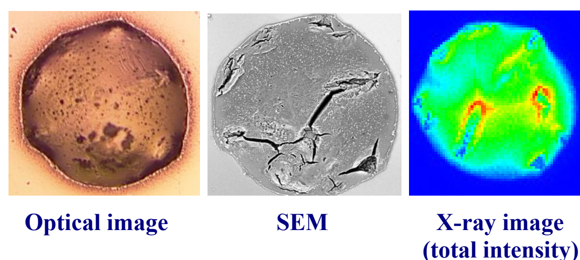

Figure 1. Comparison of optical, scanning electron microscope (SEM) and X-ray images for the multielemental standard solution deposited as a droplet on the silicon wafer and dried in 30°C. A size of the residue is about 380 µm.

It was found that for high drying temperature a size of the residue corresponds to the size of a droplet, while for low temperature the residue shrinks to much smaller size of 300-400 µm. Moreover, no losses of material was observed for low temperature and the correlations between elements were observed. The results are important for developing more accurate calibration procedures for surface sensitive x-ray techniques (*e.g.* TXRF, high-resolution GEXRF) used for determination of contaminants on semiconductor surfaces.

References

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