Polymer-Metal Coating for high contrast SEM cross sections towards single-digit nanoscale imaging

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In scanning electron microscopy (SEM), imaging nanoscale features by means of the cross-sectioning method becomes increasingly challenging with shrinking feature sizes. However, obtaining quality and high contrast results is crucial for critical dimension and patterned feature evaluation at high magnification.

Therefore, in this work, we present a new composite sample preparation method for high performance cross-sectional SEM imaging. We especially focus on high resolution and target features down to sub-10 nm. Different coating architectures including conductive and non-conductive polymer, carbon and metal are compared (Fig.1) by their performance for cross-sectional SEM. Contrast was evaluated by using histograms of intensity of gray levels directly derived from SEM images. It was found, that a stacked coating of polymer & metal greatly enhances contrast between features and background (Fig. 2). In polymer-metal coatings (PMC), optimization of contrast was explored by changing the thickness of the metal layer.

Results are discussed in terms of the effectiveness of the metal layer in blocking the escape of secondary electrons (SE) generated in between the metal coating and the patterned sample (Fig 3). Other advantages of PMCs are their cleanroom compatibility and ease of coating removal. Due to its high contrast, polymer-metal coatings for SEM can in some cases be a substitute for TEM cross section preparation and imaging.

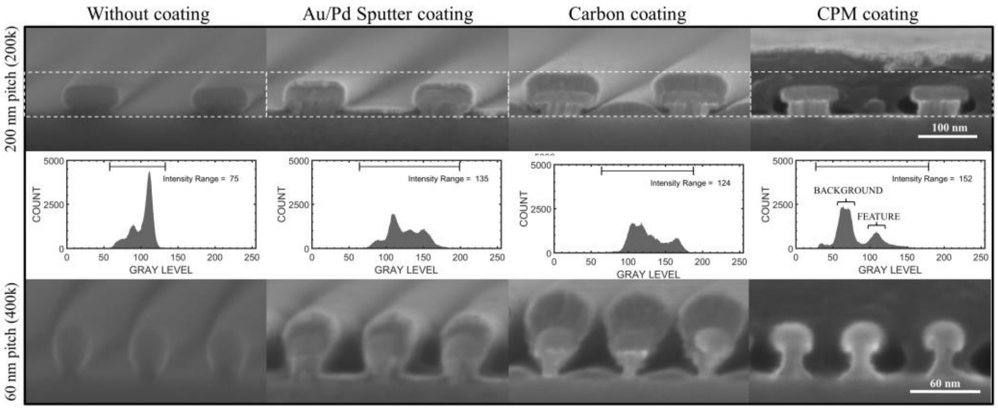

Figure 1: Comparison of cross-sections with different coatings. From left to right: without coating, Au-Pd sputter coating, carbon coating, and conductive-polymer metal coating. Sample structure: 25 nm HSQ on etched 20 nm chromium using SiO_2 substrate. **Top row:** 200 nm pitch, imaged with 200k magnification; **Center row:** histogram of area marked by dashed line. Note that CPM shows bimodal distribution between features and background. **Bottom row:** 60nm pitch, imaged with 400k magnification. All images are taken under the same conditions.

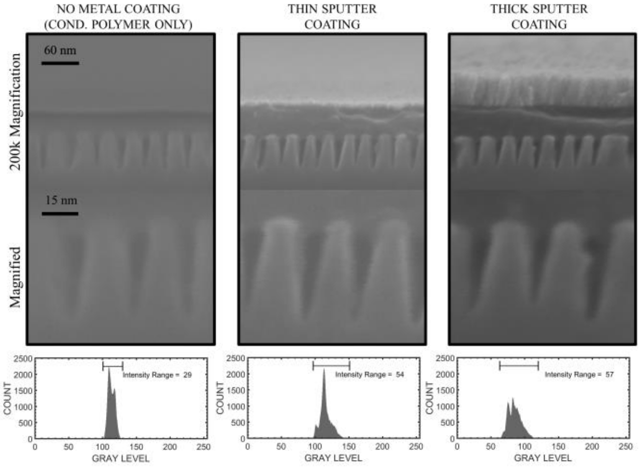

Figure 2: Comparison of CPM coating using different metal thickness. Left, no Au/Pd sputter coating, middle 6 nm au/Pd and right 50 nm Au/Pd. 2nd row: magnified images from top row to show trenches in greater detail. Feature-background contrast increases with increasing metal layer thickness. Corresponding histograms are shown below.

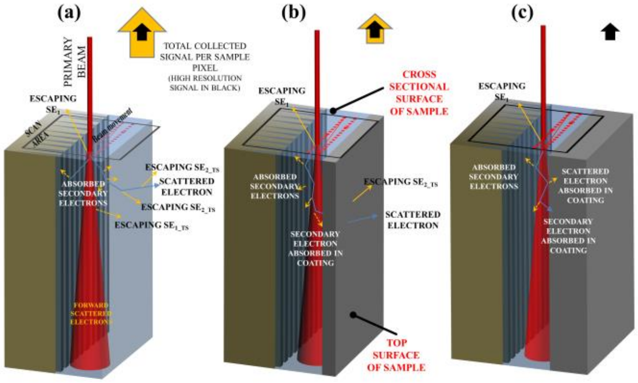

Figure 3: Schematic view of cross section under electron beam exposure with different coating stacks. Interaction of the electron beam with the sample creates multiple secondary and scattered electrons to be considered for detector signal generation.