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Nanoscale Characterisation of the Adhesion Mechanism in Thin Metal Films for Plasmonic Applications

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Deposition of thin metal films on dielectric or semiconductor substrates is central to many technological applications, including plasmonics and microelectronic devices. In this respect, good adhesion between the deposited metal and the underlying substrate is necessary, in order to ensure device integrity and performance. For plasmonic applications, noble metals such as gold and silver are the most popular choices. However, achieving the required characteristics of ultra-thin and ultra-smooth layers for plasmonic waveguides and hyperbolic metamaterials is a challenge. Gold, while more chemically stable than silver, exhibits poor adhesion to underlying substrates, requiring the deposition of a second material in between (adhesion layer), in order to obtain uniform coverage. Here, we investigate the adhesion mechanism between gold and silicon oxide substrates, using the typically chosen Cr and Ti adhesion layers, as well as organosilane adhesion layers. High-resolution transmission electron microscopy (HRTEM), transmission Kikuchi diffraction (TKD) and electron energy-loss spectroscopy (EELS) are used to understand and compare the morphology, nanostructure and chemistry of the thin film structures. The results are examined with respect to the optical properties of the corresponding structures.

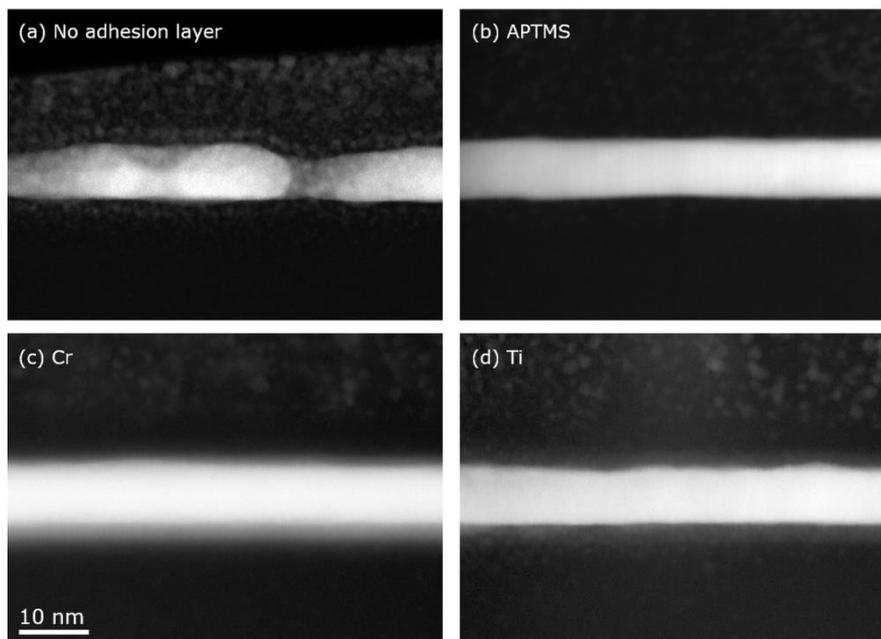


Figure 1: HAADF STEM images of a 10 nm Au layer deposited on SiO₂ substrate using different adhesion layers in cross-sectional geometry.