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Optical study of reactive sputtered oxide coatings embedded with Au clusters using HiPIMS power source

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Thin composite films consisting of metal nanoparticles in an oxide matrix are of interest for the electronics, glass, detectors, catalysis, semiconducting and bio industries. It is well know that when Au is geometrically confined it shows strong absorption near the UV-Vis region due to localized surface plasmon resonance (LSPR). Since the LSPR of noble metal nanoparticles is highly dependent on the dielectric properties of the surrounding medium, they can be used to detect molecule-induced changes nearby the nanoparticles.
In the present study nanocomposite coatings of Au clusters embedded in an Al_2O_3 matrix were synthesized by means of using reactive high power impulse magnetron sputtering (HiPIMS). The depositions were carried out in three steps by alternate depositing alumina, Au and again alumina. The thickness of the Au layer was varied between 1 and 3 nm in order to allow achieving different cluster sizes and morphologies, and nanocomposite topographies. Basic optical and morphological characterization of these coatings was carried out before and after thermal annealings at increasing temperatures in order to study their thermal stability.
Light extinction increased with the Au content. Peculiar SPR extinction bands were observed and correlated with the different cluster morphologies. With the temperature increase, the width of the SPR peaks diminished and small shifts were observed due to changes in the metal clusters morphology and in the dielectric properties of the oxide matrix.
The increased surface area and the strong (and well confined) SPR extinction bands makes this coating design optimal for gas sensing, albeit many other application fields can be envisaged.

Keywords
SPR
Al2O3
Au clusters
HiPIMS