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Au-TiO2 thin films exhibiting Localized Surface Plasmon Resonance effects and advantage of an Electron Nano-Tomography study

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Noble metal nanoparticles, NPs, especially those of gold and silver(Au, Ag), have received an intensive scientific attention due to their unique chemical and physical properties. In particular, interesting optical properties can be obtained when Au NPs are distributed into a dielectric media (e.g., TiO_2). These nanocomposite thin films, which can be prepared by reactive magnetron sputtering, followed by post-deposition thermal annealing, can manifest Localized Surface Plasmon Resonance behaviour (LSPR), which can be optimized for plasmonic sensing applications, namely those related with biosesning [1]. The LSPR effect is closely related to the size, distribution and shape of the nanoparticles, which may benefit much from a systematic 3D analysis at the nanoscale level. In this context, Electron Nano-Tomography (ENT) is a suitable approach [2] for such analysis, which was carried out for this study with a Cs-corrected Environmental TEM. ENT experiments consist in acquiring tilted series of projections of the nan-object, followed by aligning the projections to the rotation axis and reconstructing 3D sample from the aligned 2D projections [3]. ENT was performed in a Au-TiO_2 thin film, which was annealed at 400 and 600 °C to promote the microstructural changes that would allow the tailoring of its optical response in respect to the LSPR phenomena.
ENT studies confirmed the nanocomposite nature of the film, revealing the formation of nanoparticles of Au that increase in size with the increase of the annealing temperature. Moreover, the analysis showed also some particular features regarding the dielectric matrix (TiO2), which shows some local crystallization. Finally, ENT results uncoverved some particular features of the film related with the fact that NPs located near the outer surfaces of the film seem to grow significantly more than internal NPs due to the higher atomic mobility.
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