Formation of nanoclusters of Au for irradiation in multilayer ZnO/Au/ZnO thin films deposited by R.F.-sputtering

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Nanometer-sized metal and semiconductor particles inside different matrix have attracted attention because it is possible to change the physical and chemical property of the matrix material [1-4]. Among different possible synthesis techniques, multilayer arrangement irradiated by heavy ions proved a new way to obtain NC-based composite materials [6, 7], as it can virtually introduce any element in any matrix without constrains of solubility limit or high clustering free energy of formation. This work presents the formation of Au nanoclusters in ZnO thin films irradiated by ions at different energies of MeV.

Layered systems of ZnO/Au/ZnO thin films were grown on high purity silica polished substrates using R.F. sputtering. The thicknesses for ZnO layers were 250 nm, while for the Au ones were 10 nm. As samples grown they were heated at 600°C in air during 1 hour. After thermal treatment the samples were irradiated by Au ions at energies from 1 to 3.3 MeV, in order to mixing the Au layer into the ZnO films.

The samples were analyzed before and after irradiations using Rutherford Backscattering Spectrometry (RBS) and Optical Absorption spectroscopy (OA). RBS provide information about ZnO and Au distribution in the samples. The OA spectra indicate the generation of Au nanoclusters through the observation of their Surface Plasmon of Resonance (SPR).

Figure 1 shows the OA spectra obtained for each sample. The sample irradiated at 1.0 MeV present one SPR peak at 525 nm which correspond to Au ions implanted in the silica matrix; this behavior corresponds with a high sputtering yield. For the sample irradiated at 2.7 MeV the spectrum shows one SPR peak at 596 nm, indicating the formation of Au nanoclusters in the ZnO films [8]. For higher energies the samples are more stable and the two SPR peaks are observed. Those peaks indicate both the mixture of Au layer into the ZnO films and the formation of Au nanoparticles in the matrix due to the implanted ions.

Our results corroborate that it is possible to apply this method for generating nanoclusters metallic inside semiconductors matrix.

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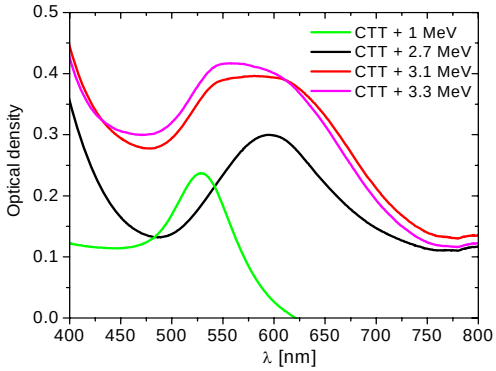

Fig. 1 Optical absorption spectra for samples heated and irradiated with Au ions at different energies. The peak at 596 nm corresponds to the SPR generated by Au nanoclusters in ZnO matrix. The peak at 525 nm corresponds to SPR by Au nanoparticles in SiO_2 substrate.

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