Plasmonic effects observed in Transparent Conductive Oxides (TCOS) thin films

J. Herrero, C. Guillén

CIEMAT Departamento de Energía, Avenida Complutense 40-Edf.42; 28040 Madrid, Spain
jose.herrero@ciemat.es

Plasmon resonance, owing to the collective oscillation electrons in response to an applied electromagnetic field, is a phenomenon observed in metals and semiconductors. In semiconductor the plasmonic energy and plasmonic frequency can be tuned from the far infrared towards the visible range [1]. Nowadays this property is a developing field with application in plasmonic based devices such as waveguides, solar cells and smart windows [2].

Heavily doped transparent conductive oxides (TCOs) are degenerated semiconductor that are beinginvestigate, both in thin film and colloidal forms for plasmonic applications [3]. Several TCOs based on indium, tin and zinc oxides have been prepared by magnetron sputtering at room temperature on glass substrates, changing different deposition parameters (discharge power, oxygen content or deposition time), and subsequently annealed in different atmosphere. They have been analyzed by X-ray diffraction, spectrophotometry, and Hall measurements; taking into account that the structural and electro-optical characteristics of such metal oxide coatings are highly related and depend on the deposition parameters apart from the material composition [4]: In this work, the plasmonic effect as a function of the annealing temperature in N_2 N_2/H_2 and air atmospheres of TCOs films have been analyzed comparatively. The purpose has been to achieve transparency in the visible range combined with high electrical conductivity, and an associated plasmon absorption in the near-infrared region.

Besides the plasmonic characteristics (plasmon resonance position and width) determined by spectrophotometry have been related to the charge transport parameters (carrier concentration and mobility) obtained also by Hall-effect measurements of the same samples. The final objective is to get abetter knowledge of the relationship between the microstructure and the electrical-properties, which can contribute to a further development of these transparent conductive oxides.

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References

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Figures

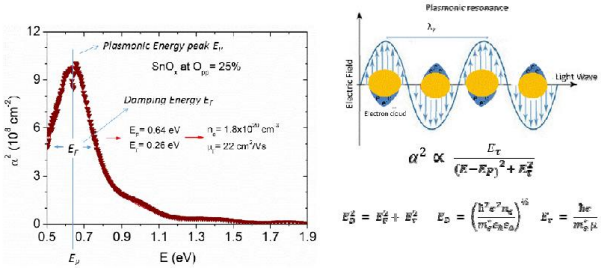

Figure 1: Plasmonic resonance effect in as-grown SnO2-x thin film prepared by DC-magnetron sputtering