Transparent aluminum nanowires electrodes with optical and electrical anisotropic response fabricated by defocused ion beam sputtering

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Abstract

Self-organized Ion Beam Sputtering (IBS) can lead to the formation of ordered metallic nanowire (NW) arrays by direct IBS patterning of a metal film supported on a flat low cost glass substrate. For increasing ion dose, the rippled metal film decomposed into a disconnected NW array which exhibits tunable anisotropic optical properties as well as anisotropic electrical conductivity. So far, for the metal sacrificial layer, noble metals as Au [1,2] or Ag [3] were chosen since, beyond having a very low resistivity, they support localized plasmon resonances in the VIS-NIR spectral range [1,2].

In this work, we have explored the possibility to find an alternative to transparent conductive oxides in optoelectronic devices. In this view, self-organized Al NWs electrodes have been obtained by defocused IBS of polycrystalline Al films grown by sputter deposition, adopting experimental conditions which are compatible with industrial processes, in view of the fabrication of low cost transparent electrodes.

The electrical characteristics have been acquired in situ during the morphological evolution of the samples, evidencing an increase of the electronic transport anisotropy as a function of ion dose between the two directions parallel and orthogonal to the NWs axis.

Optical spectra in transmission also show a large dichroism between the two directions, suggesting the role of localized plasmons in the UV spectral range. After a fluence of 1,2 x 1018 ions/cm2, the Al NWs electrodes showed transparencies of about 40% and sheet resistances, longitudinal and transverse, of 18 Ωsq and 4,5 Ωsq. At higher fluences, higher transparencies are obtained at the expense of conductivity.

References

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