Electrical and Optical Anisotropies induced by fs-LIPSS generation in FTO commercial films.

Gonzalo Gómez-Muñoz[1], Fernando Núñez-Gálvez[2,3], Rocío Ariza[1,4], Belén Sotillo[5], Javier Castillo-Seoane[2], Víctor López-Flores[2,3], Paloma Fernández[5], Carmen López-Santos[2,3] and Javier Solis [1*]

[1] Laser Processing Group (LPG), IO–CSIC, C/Serrano 121, Madrid 28006, Spain
[2] Nanotechnology on Surfaces Group, ICMS–US–CSIC, Américo Vespucio 49, Seville 41092, Spain
[3] Depto. Física Aplicada I, Escuela Politécnica Superior, Universidad de Sevilla, C/Virgen de África s/n, Seville 41011, Spain
[4] Department of Chemistry, KU Leuven, Celestijnenlaan 200F, Leuven 3001, Belgium
[5] Depto. Física de Materiales, Facultad de CC Físicas–UCM, Pl. de las Ciencias 1, Madrid 28040, Spain
*Corresponding author email: j.solis@io.cfmac.csic.es

Transparent conductive oxides (TCOs) are materials with low optical absorption in the visible spectrum, which makes them of vital importance in technological applications involving charge transfer and light management like OLED's, flat panel displays, energy harvesting, photovoltaics, smart windows or transparent heaters [1]. Recently, the feasibility of producing high optical and electrical anisotropies by fs-laser processing in Indium Tin Oxide (ITO) films has been demonstrated [2]. Still, the scarcity and decreasing cost effectiveness of ITO have spurred other TCOs as candidates to take on a much more relevant role in industrial applications. Fluorine-doped Tin Oxide (FTO) has been postulated as a natural substitute for ITO [3].

In this work, we have analyzed electrical and optical anisotropies induced by fs-laser processing of FTO thin films at high repetition rate using a beam-scanning processing approach. Anisotropies are triggered by the formation of Laser Induced Periodic Surface Structures (LIPSS) [4]. The processing conditions (fluence, number of pulses and pulse duration, scan speed…) have a great effect on the degree of anisotropy induced. Through a careful selection of parameters, it is possible to obtain a large conductivity anisotropy between the directions parallel and perpendicular to the LIPSS, with microscopic anisotropy factors ($\sigma_{\perp}/\sigma_{\parallel}$) above $\sim 10^3$ while preserving $\sigma_{\parallel}$ values within practical limits for device applications.

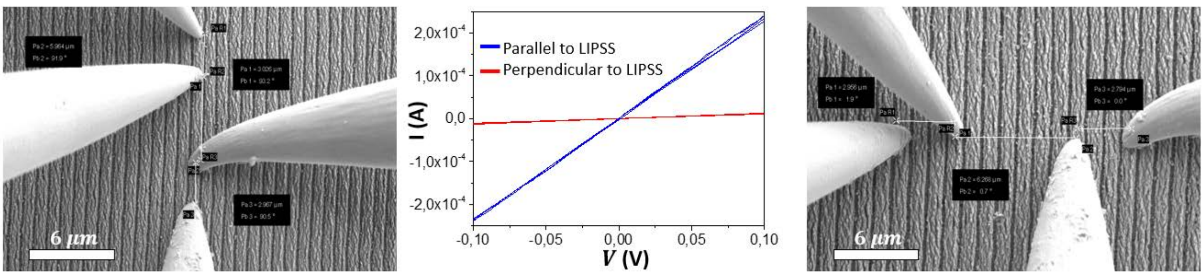

Figure1. SEM images showing the coherent propagation of LIPSS in FTO and the 4-point-probe used for measuring the material conductivity in the microscale along the direction parallel (left picture) and perpendicular (right picture) to the LIPSS. I-V curves measured in FTO upon laser processing showing the anisotropic conductivity (center).

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