WO_{3-x} THIN FILMS WITH Al, Pt Au AND Mo DOPING: SEARCHING FOR PIEZOELECTRICITY

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The present work focuses on the fabrication of WO_3 thin films doped with Al, Pt, Au and Mo with a thickness in a range of 150 nm – 250 nm. The films were deposited by radio-frequency sputtering at 225 W of RF power commercial (99.9 %) WO_3 targets, and processed to post-deposition heat treatments ranging 400 °C to 600 °C. In order to understand the influence of metal doping and heat treatments in the crystallographic structure and variation in the chemical composition that contribute to the induction of piezoelectric behavior in the films surface, an extensive characterization has been carried out using piezo force microscopy (PFM), scanning electron microscopy (SEM), energy dispersive spectroscopy (EDX), grazing incidence X-ray diffraction (GIXRD), transmission electron microscopy (TEM), Raman spectroscopy, X-ray emitted photoelectron spectroscopy (XPS) and atomic probe tomography (APT). Al-WO_{3-x} film processed at 400 °C show a piezoresponse with an estimated piezoelectric coefficient d_{33} of 35±5 pm/V. GIXRD and TEM reveal a mixed phase composition of monoclinic ($P2_1/a$) and tetragonal (P4/nmm) structures of WO_3, with domains with different polarization direction and hysteresis behavior, as observed by PFM. XPS characterization indicates a stoichiometry of $WO_{2.7}$ and Raman spectroscopy suggests a distorted octahedral tungsten vibration modes of monoclinic WO_3 at 236.9 cm^{-1}, 691 cm^{-1} and 803 cm^{-1} corresponding to O-W-O chemical bonds. APT results reveal the diffusion of matrix aluminum ions the film and the formation of segregated clusters. These results will broaden the panorama of applications of the material in sensors, actuators and other energy storage and harvesting devices that involve the use of piezoelectric behavior, in addition to semiconductor and chromogenic behavior.

Keywords: WO3, piezoresponse, APT

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