Fabrication, characterization and investigation of gas sensing properties of MoO$_3$ thin films

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Abstract: In this research, molybdenum oxide ($\alpha$-MoO$_3$) thin films were coated on glass substrates using spray pyrolysis technique. 0.05 M ammonium heptamolybdate tetrahydrate was used as precursor and deionized water as solvent. The effects of carrier gas pressure, during the spraying of the solution, on the structural, optical, morphological and gas sensing properties of thin films were studied. X-ray diffraction (XRD) pattern analysis showed preferred growth at (020) peak direction and the formation of alpha phase of molybdenum oxide. The most intensive peaks were observed in the XRD pattern of the sample prepared under the carrier gas pressure of 2 bar, which indicates better crystallization of the sample. In addition, Raman spectrum of this sample confirmed the XRD results. UV-Vis spectroscopy results showed that the sample prepared under the carrier gas pressure of 1.8 bar has the highest optical absorption and the lowest band gap ($\sim$ 3.48 eV). Scanning electron microscope (SEM) images showed the layer structure of samples. Moreover, gas sensor devices based on the prepared samples at different carrier gas pressures, were fabricated and their sensing performances were investigated. Results showed that, the work temperature (i.e. the lowest temperature with the highest gas response at the specified ethanol vapor concentration of 200 ppm) was 200 ºC and belongs to the sample prepared under the carrier gas pressure of 1.8 bar. Also, studying the effect of ethanol vapor concentration extent for this sample showed the increasing of sensitivity percent from 1.42 to 15.62 % for 100 to 1000 ppm ethanol vapor, respectively.

Keywords: molybdenum trioxide; spray pyrolysis; structural and optical properties; electron microscope; gas sensor.