Synthesis of WO3 and NiO Electrochromic Thin Films With Controlled Amount of Hydrogen

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The transition metal oxide films are commercial attractive material for creation of electrochromic (EC) devices, catalysers, gas sensors, optical switching devices and etc. The conventional EC device consists of glass substrate / transparent conducting electrode (TCO) /cathode EC film / ion-conducting film (IC) / anode EC film / TCO [1]. Such construction provides the enhanced total coloration as a result of successive REDOX reactions in the sandwich structure. It is connected with the charge injection from the anode film NiO (colored in the oxidized state) in the cathode film WO3 (colored in the reduced state) through the IC film.

Depending on the deposition conditions and techniques, films may present considerably different structural, optical and electrical behaviors, and consequently different EC behaviors. Deposited WO_3 and NiO films are mainly in the amorphous state. At the same time, the sensitivity and the rate of change in light transmission (colorization and bleaching) oxide films strongly depends on the size of the metal oxide particles. Annealing at temperatures characteristic crystallization allow obtaining the nano-structured films with the high porosity and surface area. It provides greater performance compared to amorphous and polycrystalline films with a great transparency in oxidized (WO_3) or reduced (NiO) condition. The most used element for redox reactions in oxide films is hydrogen. Obviously, the amount of hydrogen required for maximum transparency changes oxide films WO_3 and NiO in the sandwich structure will depend on many conditions. This is especially important for deposition films at the magnetron reactive sputtering of targets.

One the method of the controlled introduction of hydrogen in the EC film is the ion implantation. In the present work the influence of hydrogen dose, film thickness and structure on the electrochromic film transmittance were investigated by X-ray diffraction, Secondary Neutral Mass Spectrometry, Raman spectroscopy, Transmission electron microscopy, Photoluminescence and Spectrophotometry methods. The quantitative data allowed to determine the optimal parameters of films for the high performance electrochromic cell creation.

1. C.M. Wang, C.Y. Wen, Y.C. Chen, C.C. Wang, …, *International Journal of Chemical, Nuclear, Materials and Metallurgical Engineering*, **8**(7), (2014), 590.