A REJUVENATION STUDY OF WO_3 AND Re:WO_3: THIN FILMS DEPOSITED ON FTO SUBSTRATE USING ULTRASONIC SPRAY PYROLYSIS

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One of the challenges for electrochromic materials used in smart windows is to ensure the durability and stability of electrochromic device. Studies concerning charge insertion and extraction in electrochromic materials have shown that the degradation of these materials can be associated with ions trapped within the host structure [1].In this work, WO_3 thin films deposited by the spray pyrolysis technique, were under cyclic voltammetry processes until loss of electrochromic properties were observed. Based in previous studies related to the recovery of degraded electrochromic properties of metal oxides carried out by other research groups [2], in samples synthesized by the magnetron sputtering technique, in this work we present results on the rejuvenation of crystalline WO_3 electrochromic films synthesized employing the ultrasonic spray pyrolysis technique. WO_3 and rhenium doped WO_3 thin films were deposited on FTO substrates using the spray pyrolysis deposition technique. A 0.01 M solution of WCl_6 dissolved in dimetil formamide (DMF) was used to prepare the WO_3 thin films.In the case of films doped with rhenium, the proportional amount of doping desired was added from a solution of NH_4ReO_4 in DMF and deposited at a temperature of 500 ° C, with an air pressure of 5kg / cm^2, with a activation time of 300 ms and a time between operations of 1200 ms. Our samples presented thickness running between 600-1100 nm and electrical resistivity of 5-13Ω/□. In order to determine the WO_3 thin films electrochomic properties, cyclic voltammetry experiments were performed using H_2SO_4 as electrolyte with a fixed sweep speed varying the potential in the range of -1600 mV to -1660 mV, using platinum electrodes as counter electrode and reference electrode. Then pristine and 2% Rhenium doped WO_3 films were under 5000 ions injection and extraction voltammetric cycles. The rejuvenation of our WO_3 films was performed in samples that lost 90 % of transparency after 5000 ions insertion and extraction cycles. The noticeable rejuvenation and recovery of electrochromic properties of our materials observed in our WO_3 thin films is reported and discussed in present work.

[1]. R.-T. Wen, M.A. Arvizu, M. Morales-Luna, C.G. Granqvist, G.A. Niklasson "Ion Trapping and Detrapping in Amorphous Tungsten Oxide Thin Films Observed by Real-Time Electro-Optical Monitoring", ACS Chemistry of Materials **28** (2016) 4670−4676.

[2] R.-T. Wen, C.G. Granqvist and G.A. Niklasson, "Eliminating degradation and uncovering ion-trapping dynamics in electrochromic WO_3 thin films", Nature Materials **14** (2015) 996-1001