ELECTROCHROMISM IN WO_3 AND WO_3-Pt DOPED NANOPHASIC THIN FILMS DEPOSITED BY MOCVD ON GOLD SUBSTRATES

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Tungsten oxides, in particular WO_3, have received great interest in the last years because of their optical and electric properties, that can be potentially exploited in solar energy photothermal conversion and in displays, mirrors and window glass coatings as electrochromic materials. Electrochromism is the reversible change in optical properties when a material is electrochemically oxidized or reduced and for this reason tungsten trioxide WO_3 has received much more attention than other metal oxide based electrochromic materials, although contradictory results are still reported and the interpretation of the experimental data is still under discussion. The electrochromic reaction is normally described as the result of a double injection of protons and electrons in the tungsten oxide films. In particular, it is known that the use of platinum as doped material enhances the electrocromic and photocromic effect.

In this work, tungsten trioxide and tungsten trioxide platinum doped coatings were deposited on gold substrates employing the MOCVD technique. To this aim, commercial $W(CO)_6$ and platinum(II)acetylacetonate were chosen as precursors thanks to their high volatility and air and moisture stability. The film microstructure and morphology were analysed by XRD and SEM and the electrochromic behavior of WO_3 and WO_3-Pt doped thin films was evaluated through cyclic voltammetry in $LiClO_4$/propylene carbonate electrolyte.

The use of oxygen mixed with water vapour as reactant gas gives very brightly yellow coloured WO_3 films, while those contained the doping metallic platinum result slighly brown-yellow.

The XRD spectrum reveals the presence of polycrystalline film without appreciable preferential orientation, corresponding to the tetragonal WO_3 oxide with tungsten in the maximum oxidation state (VI).

SEM analysis of both the samples showed a surface texture regular and homogeneous without cracks or pinholes even though the Pt doped deposit highlights very close bigger grains with a very different morphology.

Fig. 1 shows the cyclic voltammogram of a WO_3 film on gold. The first cycle was characterized by an anodic peak centered at 0.6 V, which was shifted to 0.8 V in the second potential sweep. Following potential sweeps did not alter the peak position. From visual observation during the first cycle, a color change of the film, from yellow to blue, was observed when cathodically polarized. In correspondence to the anodic peak, the film showed the decoloration process from blue to yellow. After the cathodic polarization during the second cycle, the film color remained blue, even for potentials higher than 0.8 V.

If an anodic polarization current of 0.5 mA was circulated after each cycle, the anodic peak remained centered at about 0.6 V and shifting was not observed, as shown in fig. 2. The coloration-decoloration process was repeatable for more than five cycles.

Fig. 3 shows the cyclic voltammogram of WO_3/Pt films on gold. The anodic peak in the first cycle was centered at 0.6 V and it was shifted to about 1 V in the following sweeps. In this case, the coloration-decoloration process observed in the first cycle was not repeatable. The blue color characterized the film and it was maintained even after anodic polarization.

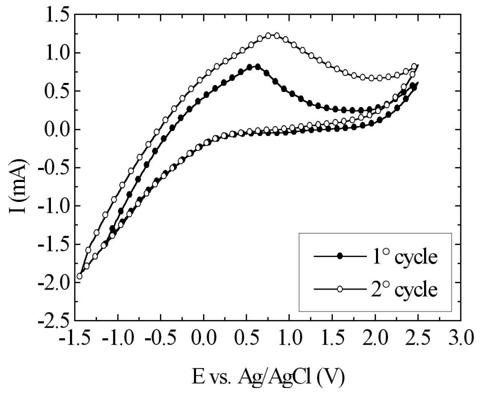

Fig. 1. Cyclic voltammogram of WO_3 film on gold.

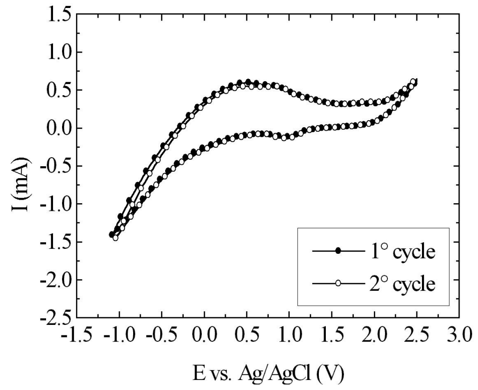

Fig.2 Cyclic voltammogram of WO_3 films on gold. Anodic polarization at 0.5 mA was carried out after each cycle.

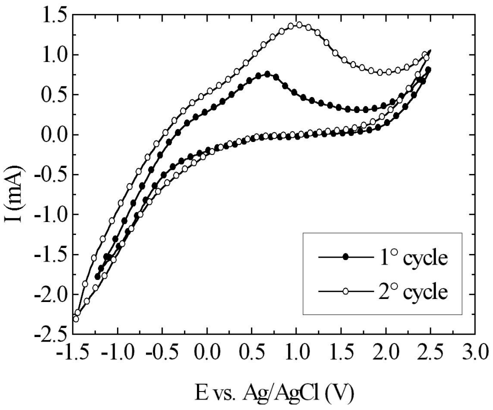

Fig. 3. Cyclic voltammogram of WO_3/Pt films on gold.