Synthesis of tungsten oxide/electrochemical reduced titanium dioxide thin films on FTO substrates and its electrochromic-pseudocapacitive properties

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INTRODUCTION

Electrochromic (EC) materials have shown to be very beneficial for a variety of applications, including smart windows, large-area information displays, rear-view mirrors for automobiles, energy saving, and other similar applications. Titanium dioxide (TiO_2) and tungsten oxide (WO_3) have garnered a lot of interest as a two-component electrochromic inorganic material because they lead to local electronic states 0.7 eV below the conduction band. Moreover, the density of oxygen vacancies can be greatly increased by reducing TiO_2 nanostructures, which in turn improves electrical conductivity and charge transfer[1]. Thus, in this work, we propose a straightforward synthetic approach to the fabrication of nanostructured $WO_3/TiO_{2\ electrochemical\ reduced}$ films on FTO electrodes, which exhibit superior optical and electrochromic properties.

EXPERIMENTAL/THEORETICAL STUDY

Nanoelectrodes made of $WO_3/TiO_{2\ el.\ red.}$/FTO (tungsten oxide/electrochemical reduced titanium dioxide/FTO) require three steps to complete. Electrochemical reduction at -20V for 30 seconds is performed on TiO_2 nanostructures generated by TiO_2 anodization of titanium films placed directly on FTO substrate through pulsed magnetron sputtering of pure titanium target (99.995%, Lesker). Finally, a WO_3 thin film is deposited using a sol-gel technique, and a new $WO_3/TiO_{2\ el.\ red.}$/FTO pseudocapacitive electrode is developed. Morphological features of surface-synthesised films are measured by atomic force microscopy (AFM), contact angle analysis (CA), and surface energy analysis, while optical properties are evaluated by UV-VIS spectroscopy. The electrochromic characteristics of a material are measured using cyclic voltammetry and chronoamperometry.

RESULTS AND DISCUSSION

UV-VIS spectroscopy is used to calculate the band gap value of the produced electrodes, and it was found that coating the TiO_2 el.red film with a thin layer of WO_3 can reduce the bandgap energy.

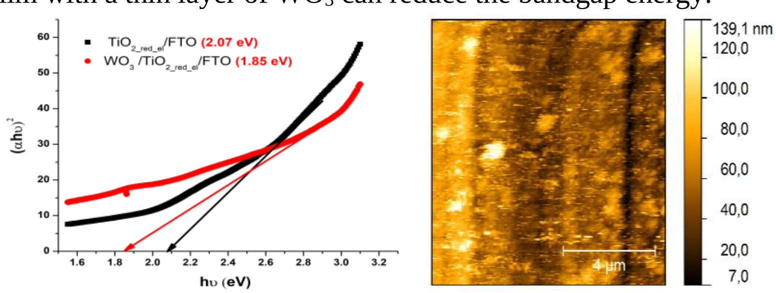

Fig. 1 Plot of $(\alpha h\nu)^2$ versus hν for band gap calculation and 2D AFM topography for obtained electrochromic electrodes

$WO_3/TiO_{2\ el.red.}$ film uniformly covers FTO substrate, as evidenced by AFM data. To put it in perspective, the composite structures measuring 1 µm in diameter and 400 nm in height are far larger than the point nanostructures at 100 nm in diameter.

CONCLUSION

New pseudocapacitive electrodes with enhanced electrochromic properties can be developed for use in smart window applications by depositing $WO_3/TiO_{2\ el.red}$ electrochromic thin films on FTO substrate with nanomorphology and low bandgap value.

REFERENCES

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