Development of Electrochromic Nanostructures Based on WO_3/TiO_2 Composite for Smart Window Applications: The Effects of Polydopamine and the Electrochemical Reduction Process

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INTRODUCTION

When a polarisation is applied, electrochromic (EC) materials undergo a redox process that changes the spectral properties of their absorption. By adjusting the amount of light and heat flowing through smart windows made of EC materials, users can maximise the building's energy consumption. By doping TiO_2 with metals, oxides or nanostructures,[1] as well as incorporating inherent defects (oxygen vacancies and Ti^{3+}) by thinning the TiO_2 layer and producing black TiO_2, the catalytic performance of TiO_2 in visible light can now be increased.[2] By using polydopamine (PD) as a dopant and an electrochemical reduction process, this study proposes a low-cost synthetic method for producing electrochromic coatings on FTO electrodes based on WO_3/TiO_2 composites with good optical and electrochromic capabilities.

EXPERIMENTAL/THEORETICAL STUDY

Three steps are required to create $(TiO_2s+PD)_{el.red}/WO_3/FTO$ electrochemical electrodes: first, a suspension of TiO_2 (TiO_{2s}) nanostructures is deposited on the FTO substrate while doped with polydopamine (PD), and the resulting film is then calcined. Then, the TiO_2s+PD film is electrochemically reduced by applying -20 V for 30 seconds and obtained of $(TiO_2s+PD)_{el.red}$ film. Finally, a WO_3 film is applied using the sol-gel process. The produced films are optically assessed using UV-VIS spectra (for measuring the band gap and transmittance), and their morphological features are established using an AFM method, contact angle measurement, and surface energy analysis. Utilizing cyclic voltammetry and chronoamperometry, electrochromic properties are evaluated.

RESULTS AND DISCUSSION

Cathodic pseudo-capacitive electrodes were characterized by UV-VIS spectroscopy to determine the band gap value. The bandgap energy is reduced by covering the surface of the $(TiO_2s+PD)_{el.red}$ film with a thin layer of WO_3.

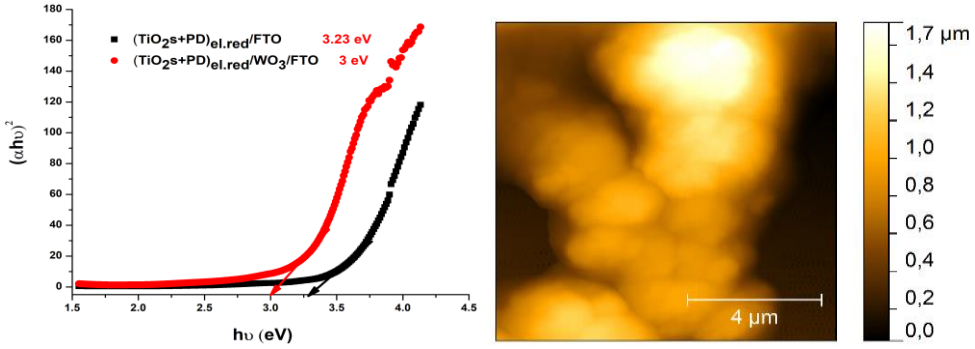

Fig. 1 Plot of $(\alpha h\nu)^2$ versus hν for band gap calculation and 2D AFM topography for obtained electrochromic electrodes

Structures on the film with diameters of 400–500 nm and heights of 200–400 nm uniformly cover the FTO substrate.

CONCLUSION

It was possible to create new cathodic pseudocapacitive electrodes with better electrochromic properties for use in smart window applications by using nanocomposite $(TiO_2s+PD)_{el.red}/WO_3$ type electrochromic thin films on an FTO substrate with a smaller bandgap value.

REFERENCES

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