Electrochromic Properties of Pure and Doped Nb_2O_5 Thin Films

Esat Pehlivan, Fatma Z. Tepehan, Galip G. Tepehan
İstanbul Technical University
Department of Physics, Faculty of Science and Letters,
Maslak, 34469, İstanbul, Turkey

Nb_2O_5 is one of the promising materials in electrochromic applications. In this study we investigate electrochromic properties of sol-gel dip coated both pure and WO_3, ZrO_2 and TiO_2 doped Nb_2O_5 thin films. Niobium (V) ethoxide, tungsten (VI) chloride, zirconium (IV) propoxide and titanium butoxide were used as precursors for Nb_2O_5, WO_3, ZrO_2 and TiO_2 sols, respectively. Nb_2O_5 sol was mixed with various percentages of the other sols. Coated samples were subjected to heat treatment at 550°C for crystallization. Optical, structural and electrochromic properties of coated films were investigated by using spectrophotometer, XRD, SEM and cyclic voltammeter. We found that refractive index of undoped Nb_2O_5 films is 1.82 at 550nm wavelength. It can be been seen from SEM pictures in the Figure 1 that WO_3 doping makes the surface of the crystallized samples more smooth with respect to undoped Nb_2O_5 films. It is found from cyclic voltammetry measurements that Nb_2O_5 films show good electrochemical reversibility. Inserted and extracted charge densities of the pure Nb_2O_5 films were improved by doping, as shown in the Figure 2. Chronoamperometric measurements showed that heat treatment at 550°C makes the current passing through the films higher with respect to unheated films (Figure 3). The same property was observed between doped and undoped films (Figure 4).

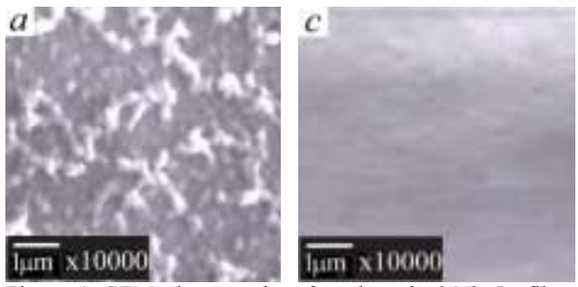

Figure 1. SEM photographs of as deposited Nb_2O_5 films a) undoped c) 5% WO_3 doped

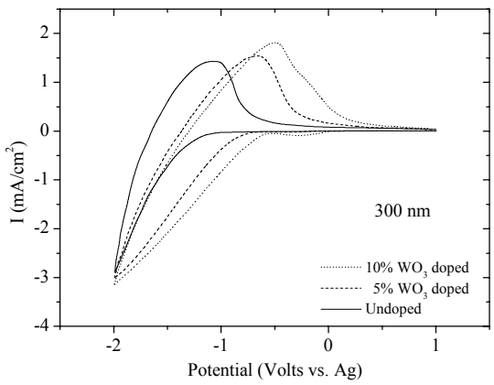

Figure 2. Cyclic voltammetry measurements of 300nm thick Nb_2O_5 films.

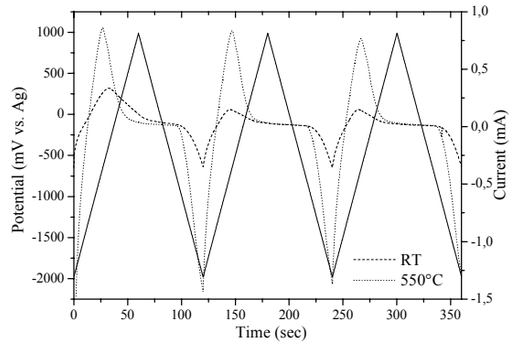

Figure 3. Chronoamperometric measurements of 5% WO_3 doped Nb_2O_5 films. Straight line shows applied potential (vs. Ag). Dashed line and dotted line show the current at room temperature and at 550°C, respectively.

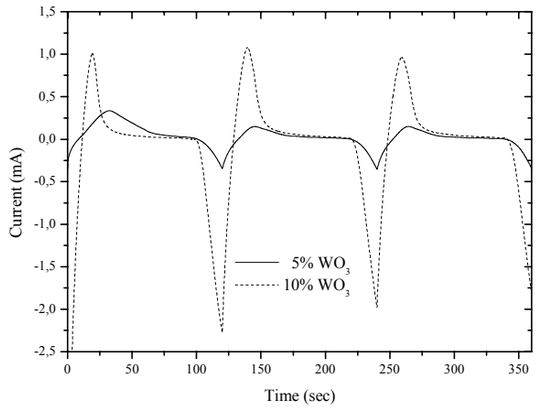

Figure 4. Chronoamperometric measurements of 5% and 10% WO_3 doped Nb_2O_5 films.