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Synthesis and Characterization of VO_2 nanocrystalline

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Abstract – Novel vanadium dioxide nanorods were fabricated via a hydrothermal method at 180˚C for 48 h from V_2O_5 in the presence of a reducing agent, the poly(diallydimethylammoniun chloride) (PDDA). The self-assembled sample was characterized by powder X-rays diffraction (XRD), electron microscopy (SEM), infrared spectroscopy (FTIR) and thermogravimetry analysis (TG/DTG). The obtained nanorods are approximately 50 nm wide and are from 300 to 500 nm long. The VO_2 nanorods are not produced by hydrothermal treatments in the absence of the PDDA polyelectrolyte.

Among the challenges in the fabrication of nanostructure compounds, the ones involving materials based on vanadium oxide appear to be particularly attractive goals, owing to their excellent properties for various important applications, such as in lithium batteries, as actuators and sensors, in catalysis and others [1]. Thermochromic VO_2 has attracted much interest because it undergoes a semiconductor-to-metal transition at approximately 68 ˚C besides presenting optical switching behavior [1].

VO_2 nanocrystalline was synthesized by the typical procedure [1], V_2O_5 was suspended in poly(diallydimethylammoniun chloride) polyelectrolyte (PDDA) and the suspension was transferred to a Teflon-lined autoclave. The hydrothermal treatment was conducted at 180˚C for 48 h. The obtained green powder was collected and washed with plenty distilled water to remove residual polyelectrolyte in the product and finally dried at room temperature.

Figure 1 presents the XRD pattern of the obtained product. All the peaks can be indexed to the VO_2 (B) phase as shown by the comparison with the JCPDS data base, card 31-1438; the product is mainly vanadium dioxide. No peaks of any other phases or impurities were detected in the XRD pattern. This indicates that a VO_2(B) phase with high purity can be obtained via the hydrothermal treatment at 180˚C using the crystalline V_2O_5 and PDDA. The TEM image (Fig. 2) presents the nanorod-like morphology and shows that the particles are approximately 50 nm wide and present lengths ranging from 300 to 500 nm. The FTIR spectra of VO_2 nanorods (Figure 3) presented signals between 400 and 1000 cm^{-1} can be attributed to various (group) vibrations of V–O type. According to the reported IR spectra of vanadium oxide, the bands about 1003 and 920 cm^{-1} are assigned to the stretching of short V=O bonds, while the bands at 520 cm^{-1} are attributed to the V–O–V octahedral bending modes [2]. The TG/DTG showed that a weight increase (≈ 4.6%) occurs in the range of 324-448˚C; it probably corresponds to the oxidation of V^{4+} leading to the formation of the yellow V_2O_5 [2]. It is important to point out that when the synthesis was performed in the absence of PDDA, the VO_2 phase was not formed. In summary, VO_2 nanocrystalline with high crystallinity was produced by reduction of V_2O_5 by a polyelectrolyte during a hydrothermal treatment. To the best of our knowledge, this is the first time that this method is proposed [3,4].

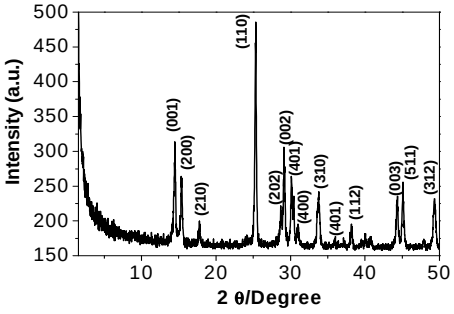

Figure 1: XRD patterns of VO_2 nanocrystalline.

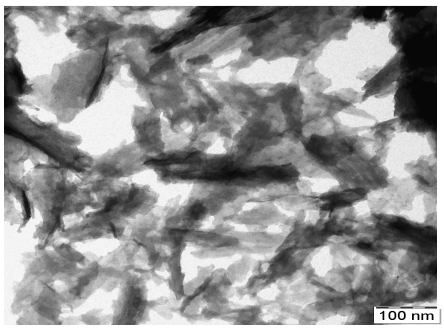

Figure 2: TEM images of VO_2 nanorods.

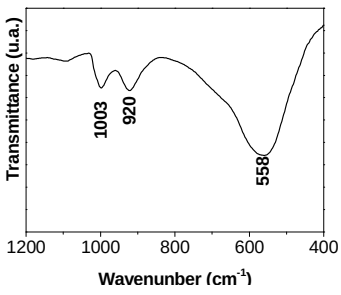

Figure 3: FITR of VO_2 nanorods.

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