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Synthesis of TiO_2 Nanoparticles by Hydrothermal Treatment and Preparation of Nanocomposite Fibers

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Abstract – Titanium dioxide nanoparticles were prepared by hydrothermal treatment of amorphous precursor under acidic conditions. Nanocomposite fibers were produced successfully by electrospinning of a PVA/water solution with TiO_2. The PVA/TiO_2 nanocomposite fibers were characterized by SEM and XRD. The SEM images showed that the diameter of electrospun fibers attained average values around 108 nm. The X-ray diffraction patterns confirmed the presence of rutile and anatase phase on the nanocomposite fibers.

Titanium dioxide nanoparticles have been synthesized by several methods, such as, solvothermal, polymeric precursor, sol–gel and hydrothermal [1]. In this sense, the hydrothermal method can be a good choice to obtain TiO_2 nanoparticles with control of size, shape and phase [2]. Due the good properties of TiO_2 particles regarding photocatalytic activity, high photostability and lack of toxicity, this material has been studied as a filler in nanocomposites [1]. In the present study, TiO_2 nanopowders were prepared by hydrothermal treatment of amorphous precursor under acidic conditions (pH = 0). The aqueous suspensions were hydrothermallized at 200°C for 2 h in a controlled reactor to crystallize the material. The TiO_2 nanoparticles were isolated by centrifuging, washed several times by distilled water, and then dried for 48 h. A known amount of TiO_2 was added to the PVA solution and ultrasonicated for 20 min. Thus, PVA/TiO_2 composites were obtained with TiO_2 contents of 2.5 and 5.0 wt% (wt. TiO_2/wt. PVA). These solutions were electrospun at two conditions of applied electric field ($KV.cm^{-1}$) and injection rate ($ml.h^{-1}$), i.e., (A)14 $KV.cm^{-1}$ and 0.2 $ml.h^{-1}$ and (B) 20 $KV.cm^{-1}$ and 0.2 $ml.h^{-1}$. The working distance was 10 cm, and the collector speed was 200 rpm. The nanocomposite fibers were dried for 8h at 60°C for subsequent characterization. The crystal structures of the TiO_2 nanopowder and the PVA/TiO_2 nanocomposite fibers were examined with a X-ray diffractometer (Rigaku Max 2500 PC). The phase composition was calculated based on the area of (101) anatase and (110) rutile peaks. The morphology of PVA/TiO_2 nanocomposite fibers was examined by scanning electron microscopy (SEM) (Leo 440).

Figure 1 shows XRD patterns of TiO_2 nanopowder synthesized by hydrothermal treatment of amorphous precursor under acidic conditions. It can be seen that the main peaks of anatase and rutile phase appeared clearly, at $2\theta = 25.2^{o}$ and 27.4^{o}. The phase composition of sample was 67% of rutile and 33% of anatase. The SEM image of the PVA nanofiber with 2.5 wt% TiO_2 is shown in Figure 2. It can be seen that the morphology was uniform, and the average fiber diameter was 108 nm. Also, there wasn´t visual segregation of phases, probably indicating a good distribution of the loaded TiO_2 nanoparticles.

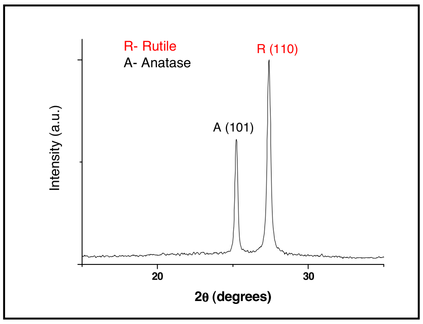

Figure 1: X-ray diffraction patterns of TiO_2 nanopowder.

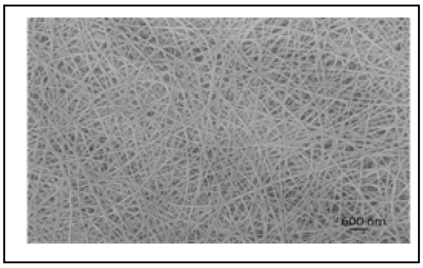

Figure 2: SEM image of electrospun PVA/TiO_2 (2.5 wt%).

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