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Fabrication and characterisation of electrospun barium titanate and polyvinly pyridine composite nanofibers

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ABSTRACT

$BaTiO_3$-PVP composite nanofibers were successfully produced by sol–gel and Electrospinning method. These fibers were calcinated at 500 °C for 2 h and characterized by XRD, SEM, FTIR, and TG-DTA. XRD measurements confirm that the existence of the pure anatase phase of ($BaTiO_3$-PVP) fibers. FTIR studies reveals that the formation of metal oxide bond at 570–600 cm^{-1}. TG-DTA analysis of $BaTiO_3$-PVP composite nanofibers indicate that most of the acetate and organic groups were removed approximately at 700 °C. SEM studies shows the fibers formed with diameter in the range of 200 nm. Finally electrospun $BaTiO_3$-PVP nanofibers diameter is decreased with increasing the applied voltage.

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1. Introduction to Barium titanate ($BaTiO_3$)

Barium Titanate ($BaTiO_3$) is one of the very important lead free ferroelectric material with large number of applications such as transducers, dielectric capacitors, in non-volatile ferroelectric random access memories, sensors and actuators, in solid oxide fuel cells, etc. [1,2]. If these ferroelectric are prepared in nanosize we are expected to improve their properties. Nanostructured $BaTiO_3$ like fibers wires and tubes are very attractive because of their high surface area to volume ratio. $BaTiO_3$ ferroelectrics are polar materials that exhibit net spontaneous polarization and hysteresis behavior in external applied electricfield. $BaTiO_3$ with perovskite structure is widely used in various electric applications such as Multilayer Ceramic Capacitors (MLCCS), and ferroelectric random access memories, etc. [3,4]. Recently $BaTiO_3$with pvp composite nanofibers were fabricated by using Electrospinning method with some dopants also because Electrospinning is a very simple and straight forward technique for the preparation of polymer and oxide nanofibers. Initially this technique was used for the preparation of polymer nanofibers [5–8]. From last few years this technique has been used for the preparation of metal oxide/ceramic nanofibers such as Titania, Aluminia, Silica, Zircon, Nickel oxide, Tin oxide, Lead zirconate titanate and other oxide materials [9–11].

Electrospinning apparatus consisting of a syringe pump, metal needle, high voltage power supply and a grounded collector etc. This Electrospinning process involves the application of a strong electrostatic field to a polymer solution filled in a syringe with metallic needle. The positive terminal of a high D. C. source is connected to the counter electrode in the form of a metal plate or aluminium foil placed at a fixed distance.

Under the influence of the electrostatic field, the solution experiences repulsive force. As the voltages surpass a threshold value, electrostatic forces overcome the surface tension and a fine charged jet is ejected. The jet moves towards the counter electrode and subdivides into large numbers due to High repulsive force, finally deposits in the form of nanofibers on the counter electrode [12–14]. In our work we are focused on fabrication and characterization of $BaTiO_3$-PVP composite nano fibers with different applied voltages by keeping flow rate and jet distance at constant and studied the effect of voltage on the morphology of the nanofibers.

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