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Effect of Calcination Temperature on Microstructural Evolution of Electrospun ZnO Fibers

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ABSTRACT. Development of portable or wearable devices demands for flexible, lightweight or even foldable materials for fabrication. In this respect, electrospinning offers a cost-effective, high throughput, versatile and scalable route for the production of flexible micro/nanofibers on almost all kinds of surfaces. In this work, semiconducting ZnO fibers of high aspect ratios were electrospun from organic precursor of ZnO solution. The effect of calcination temperature on the microstructures of the electrospun fibers was investigated. Simultaneous thermal analysis (STA) was used to monitor the temperature at which the organic precursor was removed to form ZnO. X-ray diffraction (XRD), on the other hand, was used to monitor the phase formations at various heating stages. Field emission scanning electron microscope (FESEM) equipped with energy dispersive spectrometry (EDX) was employed for morphological study of the ZnO produced. Continuous single phase ZnO fibers started to form at a temperature of around 460 °C and evolved through various stages of microstructural formations, from tubular-like structures to segmentation of granular structures and hierarchical structures at further increases in calcination temperatures. The ZnO fibers experienced increasing crystallinity and stoichiometry change during the heating process. When mechanically bent, the fibers were able to generate current pulses of between 0.1 to 10 nA.

Keywords: *Zinc oxide, Electrospinning, Calcination;*

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1. INTRODUCTION

ZnO is an n-type semiconductor that possesses richness in growth geometries, from rod, tube to more complex morphologies such as hexagonal plate-like or flower-like structures [1-3]. Due to its unique properties such as large excitation binding energy (60 meV) at room temperature, wide band gap (3.37 eV), thermal stability, large piezoelectric coefficient and irradiation resistance, it has been used as the building blocks in various solid state devices such as sensors, cosmetics, liquid crystal displays, optoelectronics, photovoltaic and piezoelectric devices [4-6]. Moreover, ZnO has a polar crystalline structure which produces a noncentrosymmetric charge gradient in the crystal lattice when subjected to an external force. Such property has made ZnO nanofibers good candidate materials for piezo generators as these nanostructures are ultrasensitive in converting mechanical forces to high output voltages due to their high degree of flexibility for deformation [7].

ZnO fibers can be fabricated using electrospinnning, a simple, cost effective and high throughput technique that uses electric field to provide sufficient tensile force to overcome the surface tension of a polymer fluid so that it can be ejected through an electrically charged needle to form fibers onto an electrically grounded collector [8]. Advantages of electrospun fibers are that they are flexible, lightweight,