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A simple method to synthesize polyhedral hexagonal boron nitride nanofibers

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Abstract

Hexagonal boron nitride (h-BN) fibers with polyhedral morphology were synthesized with a simple-operational, large-scale and low-cost method. The sample obtained was studied by X-ray photoelectron spectrometer (XPS), electron energy lose spectroscopy (EELS), X-ray powder diffraction (XRD), Fourier transformation infrared spectroscopy (FT-IR), etc., which matched with h-BN. Environment scanning electron microscopy (ESEM) and transmission electron microscope (TEM) indicated that the BN fibers possess polyhedral morphology. The diameter of the BN fibers is mainly in the range of 100–500 nm.

Keywords: Hexagonal boron nitride; Nanofibers; Polyhedral

1. Introduction

h-BN is a material which has received considerable attention due to its properties such as hardness, chemical inertness, high thermal conductivity and the capability of hydrogen uptake [1–3]. Since the BN nanotube was formally reported by Chopra et al. [4], many researches on the BN fibers, especially the BN nanotubes (BNNTs) have been published due to their potential applications in prospective electronic and mechanical devices [5–12]. As an inorganic fiber, the BN fibers also have potential applications to improve the performance of ceramics [13]. The study of BN fibers was not suspended on this stage. Many methods were developed to synthesize functional BN fibers to make better purification of BN fibers, develop new functional BN fibers which have a special application and so on [14–16]. From now on, there are only little investigations on the practical application of BN nanofibers, mainly because there are no reliable methods to produce bulk BN nanofibers with high purity [16]. This bewildering complexion has promoted the essentiality to develop a new facile method to produce bulk amounts and high purity h-BN nanofibers.

The synthesis of h-BN fibers with high performance was considered as a technological challenge and needs appropriate method for a good processibility [17,18]. BN nanotubes have been synthesized using different methods, such as chemical vapor deposition [5], arc discharge [4], ball-milling [8], laser ablation [9], carbon nanotube substitution reaction [10] and pyrolysis[11,18]. Among them, the ball-milling/annealing method was considered as an effective way to synthesize BN nanofibers bulkily. But most of these growth methods have introduced metal catalysts and could not synthesize BN fibers with high purity. The other optional method is pyrolysis. Cylindrical BN fibers without tubular morphology could be synthesized using this method. However, the h-BN nanofibers with polyhedral morphology reported here is, to our knowledge, hitherto unknown for h-BN. This is a novel morphology of BN nanofibers and is different from the cylindrical and tubular BN nanofibers. Hamilton et al. have reported the first synthesis of tubular BN fiber in 1993 [19]. Their BN fibers

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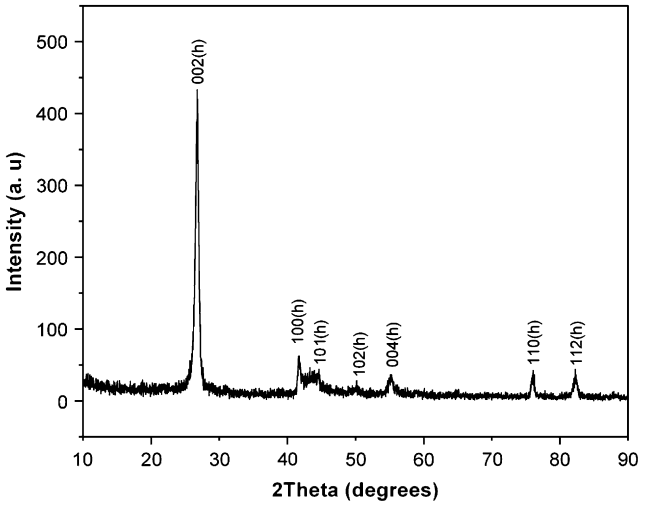

Fig. 1. XRD patterns of BN sample.

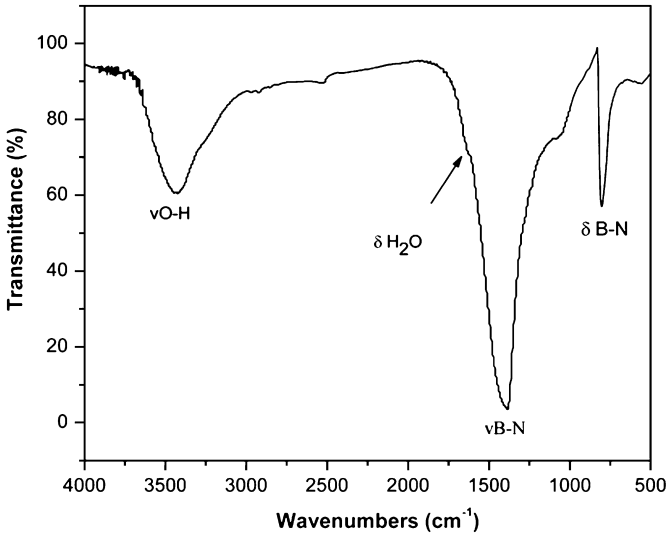

Fig. 2. FT-IR spectra of BN sample.

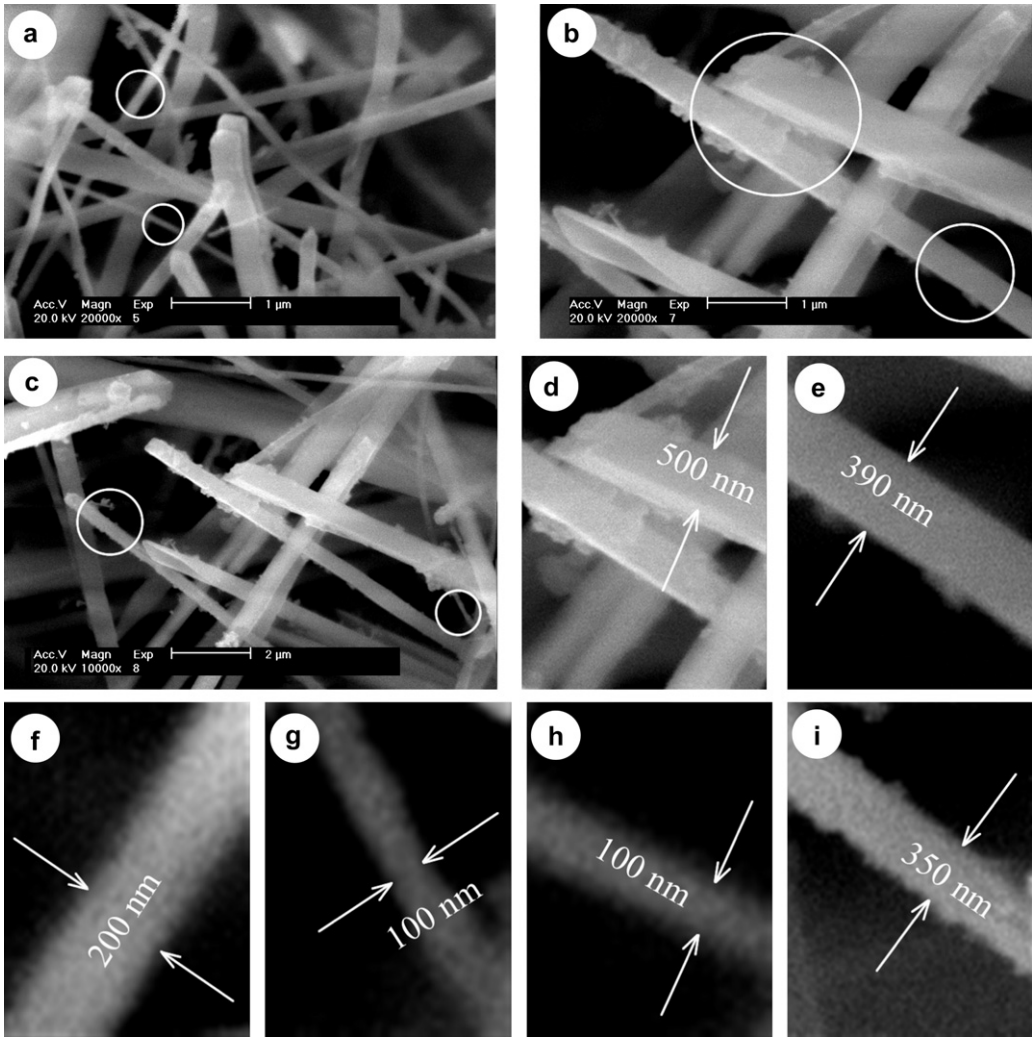

Fig. 3. (a–c) ESEM images of the sample. (d–i) Amplificatory ESEM images of local fibers.