



Fabrication of single-crystalline gallium nitride nanowires by using alginate as template

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ABSTRACT

Hexagonal gallium nitride nanowires were synthesized successfully by solvothermal method with *alginate* as template. The microstructure, morphologies and compositions of the as-prepared product were characterized by powder X-ray diffraction (XRD), transmission electron microscopy (TEM), selected area electron diffraction (SAED), high resolution transmission electron microscopy (HRTEM), and energy dispersive X-ray (EDX). Results suggested that the rod-like nanowires were hexagonal single-crystalline GaN growing along [001] direction. The photoluminescence spectra (PL) of the GaN revealed that the as-synthesized sample possesses excellent optical properties.

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1. Introduction

With the development of commercial blue-light emitters, GaN has become one of the most promising materials [1–3]. GaN nanowires attracted much attention due to their distinctive optical, electrical, and magnetic structural properties [4–9]. Wurtzite gallium nitride nanostructures grew by thermal reaction using gallium oxide and ammonia as reactants [10]; GaN crystals grew in molten solution with Ga-free solvent using a temperature gradient [11]; Bulk GaN crystal grew by the high-pressure ammonothermal method [12]; Vapor–liquid–solid (VLS) crystal growth mechanism had been widely used for the synthesis of fiber-like GaN [13]. In this letter, GaN materials were synthesized successfully by solvothermal method at 350 °C using alginate as template, which had not been reported before. The solvothermal method can effectively prevent the products from oxidizing and may synthesize GaN under mild conditions [14]. The alginate plays an important role in the process of forming GaN nanowires.

2. Experiment

All the manipulations were carried out in a dry glove box with N₂ flowing. In the typical process, NaN₃ (2.2 g) and GaCl₃ (2 g) were put into a stainless steel autoclave of 50 ml capacity, and then the autoclave was filled with 25 ml anhydrous dimethylbenzene up to 60% of the total volume. The autoclave was sealed and maintained at

350 °C for 24 h in a furnace, then allowed to cool to room temperature naturally. The products were collected and washed with absolute ethanol and distilled water for several times to remove the impurities.

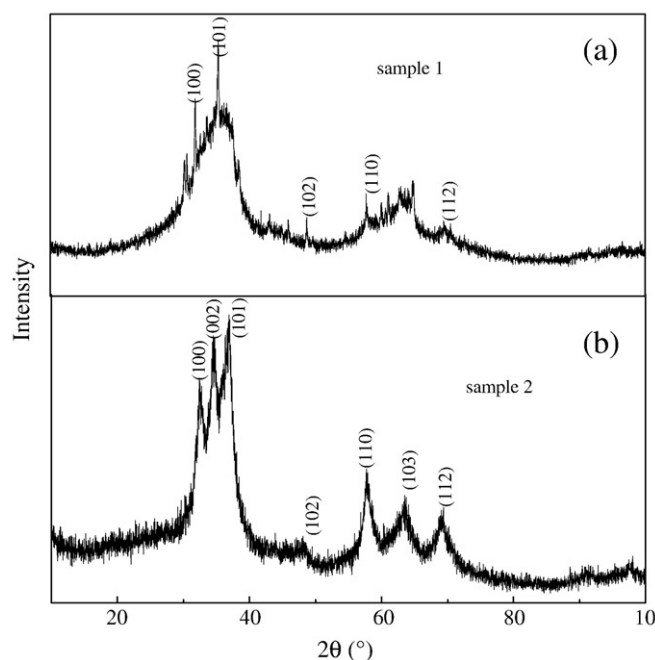


Fig. 1. XRD pattern of the synthesized products (a) sample 1; (b) sample 2.

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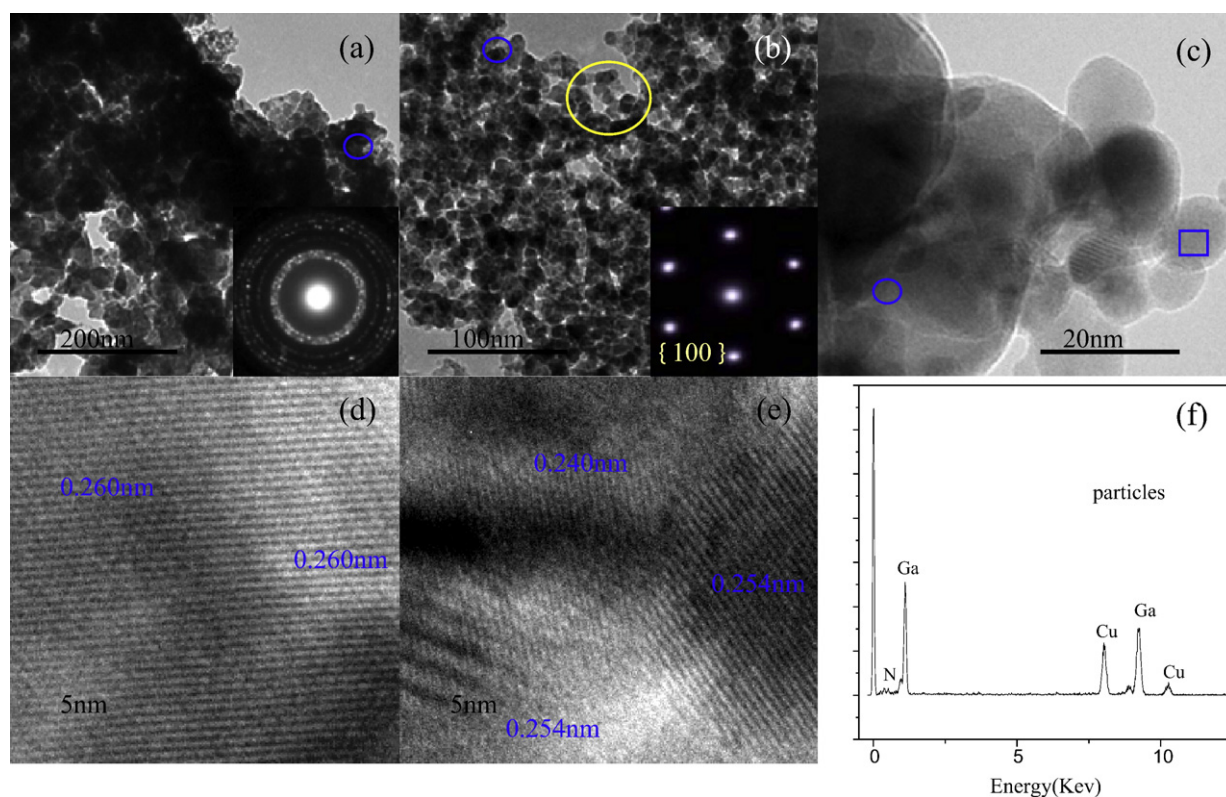


Fig. 2. (a and b) TEM images of GaN nanoparticles; (c) a magnified TEM image of GaN nanoparticles; (d and e) two HRTEM of GaN nanoparticles (taken from blue zone in (c)); (f) The EDX image of GaN nanoparticles (taken from blue zone in (a)).

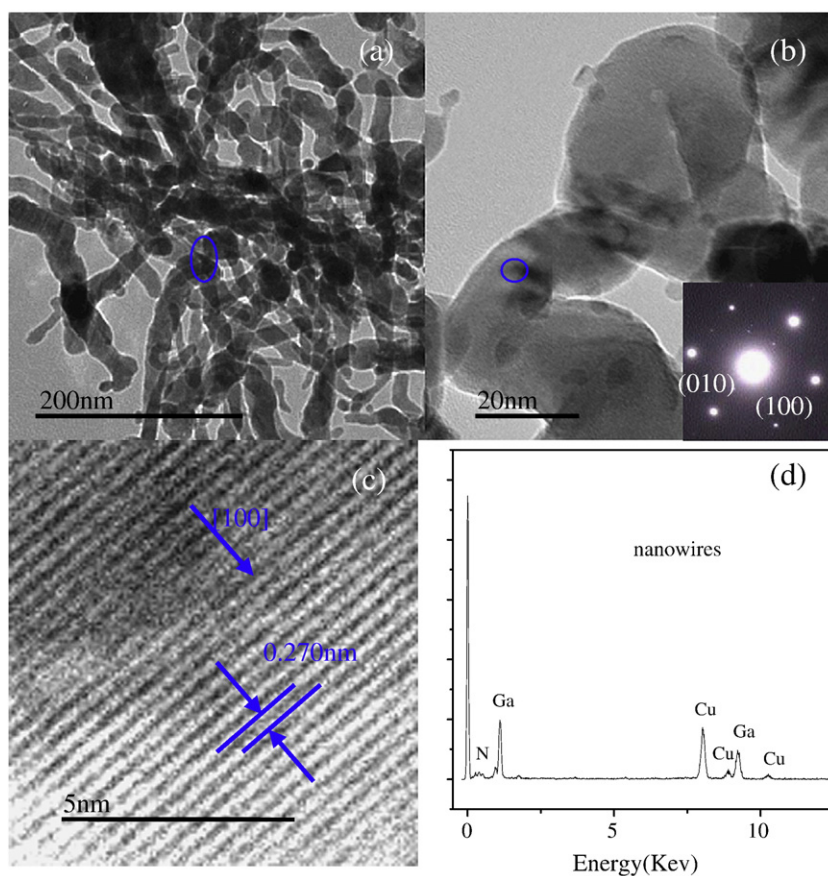


Fig. 3. (a) A TEM image of GaN nanowires of special structure; (b) a magnified TEM image of the GaN nanowire (taken from the blue zone (c) an HRTEM image of the GaN nanowire (blue marked zone in (b)); (d) the EDX image of the GaN nanowires (blue marked zone in (a)).

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