Materials Letters 204 (2017) 57–60

Contents lists available at ScienceDirect

Materials Letters

journal homepage: www.elsevier.com/locate/mlblue

Hexagonal bottom-neck ZnO nano pencils: A study of structural, optical and antibacterial activity

S. Kaviya [a,*], S. Kabila [b], K.V. Jayasree [b]

[a] Department of Chemistry, Indian Institute of Technology Madras, Chennai 600036, TN, India
[b] Department of Physics, Nallamuthu Gounder Mahalingam College, Pollachi 642001, TN, India

ARTICLE INFO

Article history:
Received 12 April 2017
Received in revised form 30 May 2017
Accepted 4 June 2017
Available online 5 June 2017

Keywords:
Biomaterials
ZnO nanoparticles
Hexagonal bottom-neck
Antibacterial
Pomegranate peel
X-ray techniques

ABSTRACT

We have shown a protocol for the synthesis of monodispersed, reproducible hexagonal bottom-neck ZnO nano pencils which eliminate the usage of specific reaction conditions and substrate for the growth of the particles. The particles were synthesized from the aqueous extract of pomegranate peels under the sunlight irradiation and were characterized by spectroscopic and microscopic techniques. We have studied the anti-bacterial activity of the synthesized nanoparticles using *Escherichia coli* (Gram-negative) and *Staphylococcus aureus* (Gram-positive). Furthermore, we compared the activity of the particles with the commercial ZnO nanoparticles and ZnO nano rods.

1. Introduction

In the light of growing anti-microbial resistant pathogens, there arises a need to develop several strategies to overcome the anti-microbial resistant pathogens [1]. Application of nanotechnology which involves the development of novel nano-scale composites/-materials to combat the anti-microbial resistant pathogens has been gaining importance due to the many advantages they possess. ZnO nanoparticles (NPs) have been studied for various biomedical and pharmaceutical applications such as antimicrobial agents, drug delivery, gene delivery, bio-imaging and bio-sensor due to the unique biocompatibility it contains [2]. Furthermore, antimicrobial activity of ZnO NPs is more stable when compared to other organic materials [3]. Various synthetic strategies are available for the preparation of ZnO NPs with different size and shape [4] in which the surface capping/stabilizing agent is considered to be significantly important for the shape selective synthesis of NPs as they directly influence the toxicity of the NPs. However, the toxicity and replacement of capping agent are certain limiting factor for the application of ZnO NPs. The biosynthesized nanoparticles stabilized by the plant/microbe extract [5] are less toxic compared to nanoparticles stabilized by chemical methods which involves the usage of several toxic chemicals (cetyl trimethylammonium bromide (CTAB)), [6]. Various research on the biosynthesis of ZnO nanoparticles, have reported the usage of *Trifolium pratense* flower [7], *Aloe barbadensis miller* leaf [8], *Pongamia pinnata* leaves [9], rambutan peel [10], *Corymbia citriodora* leaf [11] and *Aeromonas hydrophila* cell [12] extract for the stable and toxic-free synthesis of ZnO NPs. However, all of these methods have yielded only spherical nanoparticles of ZnO NPs.

As size and shape of the NPs have a strong impact on their application and usage, we have developed a simple strategy for the formation of hexagonal bottom-neck ZnO nano pencils using aqueous pomegranate peel extract. The extract is a rich source of poly phenols [13,14] (punicalagin and punicalin) which stabilizes the ZnO NPs without any toxic effects [15]. The shape of the synthesized NP is controlled by varying the concentration of the precursor compound. Additionally, we have studied the antibacterial activity of the synthesized nanoparticles using *Escherichia coli* (Gram-negative) and *Staphylococcus aureus* (Gram-positive). Finally, the efficiency of the nanoparticle is equated with the commercial ZnO NPs and ZnO nano rods.

2. Experimental

Chemicals were obtained from Sigma-Aldrich (USA) and the ripened pomegranate was acquired from the marketplace at Chennai (TN, India). ZnO nanoparticle was produced by implementing an eco-friendly approach using pomegranate (*Punica granatum*)

* Corresponding author.
E-mail address: kaviyahere@gmail.com (S. Kaviya).

http://dx.doi.org/10.1016/j.matlet.2017.06.018
0167-577X/

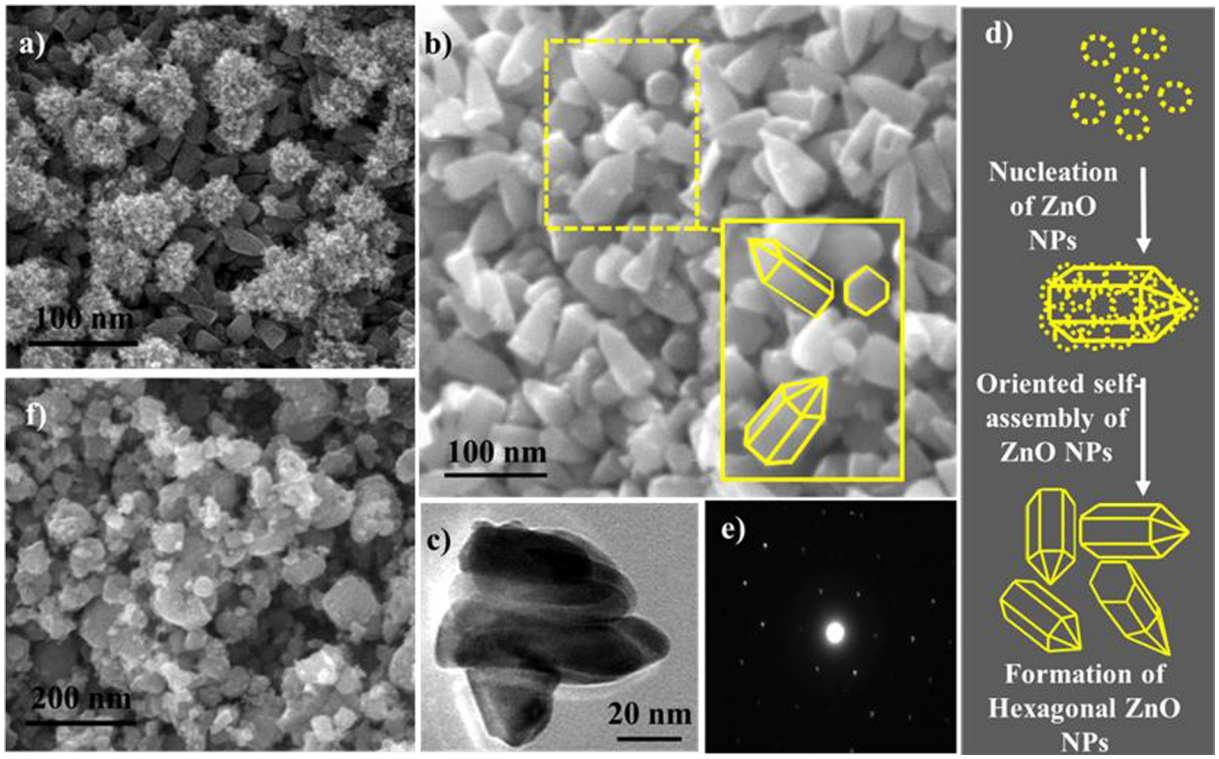

Fig. 1. (a, b and f) SEM image of ZnO-2, ZnO-3 and ZnO-4; (c) TEM image of ZnO-3, (d) schematic representation of hexagonal bottom-neck (HBN) ZnO nano pencils (ZnO-3) growth and (e) SAED pattern of HBN-ZnO nano pencils (ZnO-3).

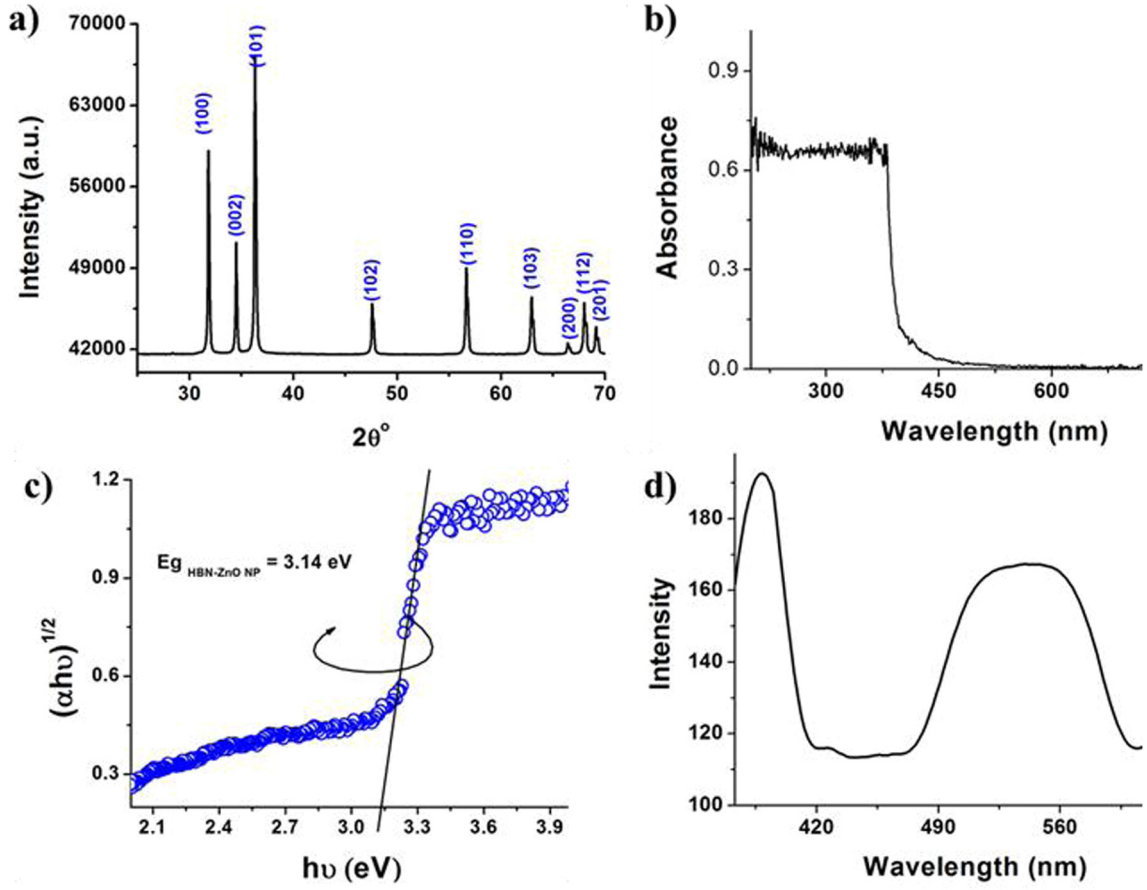

Fig. 2. a) XRD b) diffused reflectance spectra c) Tauc's plot d) photoluminescence spectrum of hexagonal bottom-neck ZnO nano pencil.