Fabrications of Hybrid Zinc Oxide Nanorods -Carbon Nanotubes Cotton

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Abstract: The preparation and characterization of zinc oxide (ZnO) nanostructures on green carbon nanotubes cotton (CNTC) was investigated. CNTC from waste cooking palm oil (WCPO) was synthesized via chemical vapor deposition (CVD) reactor. The CNTC is soft, fluffy, light weight and resembles cotton fiber used in textiles. ZnO nanostructures were grown on CNTC using chemical bath deposition method. It was observed that ZnO nanorods with aspect ratio of 9.32 of were successfully grown on the green CNTC. The combination of ZnO and CNTC hybrid is a promising composite that can be further explored in the application of electromagnetic absorbing material, piezoelectric nanogenerator and sensors.
Keywords**:** carbon nanotubes cotton, waste cooking palm oil, zinc oxide nanostructures

INTRODUCTION

Nowadays the usage of palm cooking oil has tremendously escalated due to the influx of small and medium enterprises (SMEs) into the food and beverages manufacturing industry. Hence, the amount of waste cooking oil has increased simultaneously which leads to uncontrolled dumping and discharging to the environment. In order to solve this problem, the waste cooking palm oil (WCPO) was recycled and turned into economic potentials. To date, most of research attempts in Malaysia using WCPO are mostly in the expense of turning it into inexpensive feedstock for biodiesel production. A research led by a local group demonstrated that WCPO from domestic frying can be utilized as an efficient, economical and environmentally friendly carbon source for the production of high purity CNT [1]. Another research also reported on refined vegetable oil replaced by WCPO as a source of triglycerides for biodiesel production [2]. WCPO was further explored as a carbon source to produce high purity (87%) and crystallinity for supercapacitor application [3]. Carbon nanotube cotton (CNTC) is a special type of CNTs which exhibit good electrical conductivity. CNTC is a mixture of multi-wall and single-wall CNTs, physically similar to cotton, which is soft, fluffy and lightweight, consisted of multiple long threads of individual CNTs. The CNTC, once flattened, formed a thin layer of carbon sheet suitable as a substrate. It is flexible and comparable to commercial flexible substrates commonly used in mobile electronic devices such as polyethylene terephthalate (PET) and polyethersulfone (PES). A study on CNT and ZnO hybrid nanocomposite was reported on the fabrication of single-walled carbon nanotubes–ZnO nanorods (SWCNT-ZnONR) as resistive gas sensors for NO gas detection [4]. Multi wall carbon nanotube (MWCNT) sponges were synthesized with a domestic microwave oven yielded sponges of about 2.2 cm^2, fabricated as light emitting transistor (LET) and field effect transistor (FET)[5].

MATERIALS AND METHODS

WCPO as carbon source was used as the starting material for CNTC synthesis. Ferrocene and thiophene were added as catalyst and growth rate enhancer. The synthesis was carried out at temperature ranging from 1000 °C to 1200 °C. Zinc oxide (ZnO) buffer layer was deposited on the CNTC using a sputter coater by 99.9% ZnO target. Growth solution for ZnO nanostructure growth

was prepared by dissolving 0.05 M of zinc nitrate hexahydrate and hexamethylenetetramine (HMT) in distilled water. After that, the sample was leave in an oven at 90 °C for 6 hours. The characterization was carried out using Field Emission Scanning Electron Microscopy (FESEM), Raman Spectroscopy, EDX analysis and X-ray Diffraction (XRD).

RESULTS AND DISCUSSION

Fig. 1(a) shows the FESEM image of CNTC-ZnO hybridization revealing a dense array of ZnO nanorods of uniform length grown around the confinement of the CNT cotton tubular surface. The average diameter of the nanorods is 110 nm with length of 1.02 µm. Meanwhile, in Fig. 1(b), the quantitative EDX result confirmed the presence of zinc oxide on CNTC using CBD method by 21.7% Zn, 63.0% c and 15.2% O. The XRD pattern of CNTCZnO hybrid is shown in Fig. 1(c). It was observed that at 2θ values, ZnO nanostructure strongest peak appeared at 31.8°, 34.5°,36.3°,47.6°, 56.7°, 63.0° and 68.1° corresponding to the lattice plane (010), (002), (011), (012), (110), (013) and (112) respectively. All the sharp peaks indicate the sample was well crystallized. Meanwhile the broad peak at 26.2° and 44.5° at 2θ corresponds to the CNTC peaks.

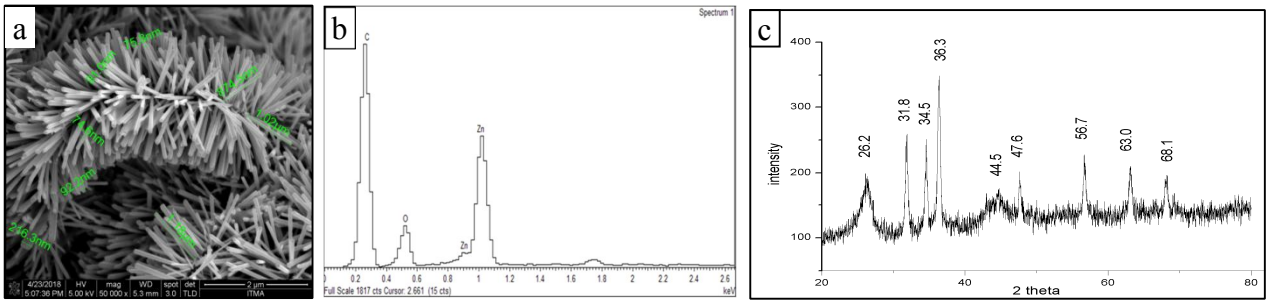

Fig. 1 (a): FESEM image of CNTCZnO hybrid, (b) EDX analysis of CNTCZnO and c) XRD pattern of CNTCZnO

CONCLUSIONS

CNT cotton has successfully synthesized from chemical vapor deposition process using waste cooking palm oil as the carbon source. ZnO nanorods have successfully grown on the CNTC using chemical bath deposition method. The nanorods were observed to be having a high aspect ratio of 9.32 and diameter of 70 – 220 nm. The hybridization of ZnO nanostructures with CNTC is a combination that can be applied in small scale electronic devices as well as in electromagnetic absorbing material, piezoelectric nanogenerator and sensors applications.

REFERENCES

[1] Suriani, AB, Md Nor, R, Rusop, M. *J. Ceram. Soc. Jpn.*, 2010, **118**, 10, 963-968
[2] Tan, KT, Lee, KT, Mohamed, AR. *Energy*, 2011, **36**,4, 2085
[3] Suriani, AB, Norhafizah, J, Mohamed, A, Mamat, MH, Malek, MF, Ahmad, MK. *J Mater Sci-Mater El.*, 2016, **27**,11, 11599
[4] Oweis, RJ, Albiss, BA, Al-Akhras, MA, Al-Widyan, MI. *Journal of Elec Materi*, 2014, **43**,9, 3222
[5] Ortega-Cervantez, G, Gómez-Aguilar, R, Rueda-Morales, G, Ortiz-López, J. *J Mater Sci*: *Mater Electron*, 2016, **27**, 12, 12642