# Characterized and toxicity study of carbon nanotubes synthesis from fermented tapioca for tribological applications

I. Nurulhuda[1,*], R. Poh[2], M.Z. Mazatulikhma[1], M. Rusop[3]

[1)] Faculty of Applied Sciences, Universiti Teknologi MARA, 40450 Shah Alam, Selangor, Malaysia.
[2)] Department of Molecular Medicine, University of Malaya, 50603 Kuala Lumpur, Malaysia.
[3)] NANO-Electronic Centre, Faculty of Electrical Engineering, Universiti Teknologi MARA, 40450 Shah Alam, Selangor, Malaysia.

[*]Corresponding e-mail: nurul850@ns.uitm.edu.my

**Keywords**: FTIR; FESEM; neuroblastoma cells

**ABSTRACT** – Carbon nanotubes were first introduced by Ijima in 1991. From that day, it was widely used in many fields such as engineering, physics and medical fields, including improving tribological behavior and material mechanical properties for orthopedic used. Many precursors varied from solid to liquid used to synthesis it. In current study, carbon nanotube was successfully synthesized by using natural source precursor, fermented tapioca. The synthesized carbon nanotubes were characterized by Raman spectroscopy, FESEM, FTIR and TGA in order to study the physical and chemical properties before subjected to cells toxicity screening on neuroblastoma cells.

## 1. INTRODUCTION

Carbon nanotubes (CNT) had beed used in many applications varied from engineering until in the medicine. This include of used CNT to improve tribological behaviour and material mechanical properties of orthopedic. Other than that, CNT based electrodes can be considered for integrating implantable orthopedic devices since it have effect on osteoblast and osteoclasts metabolic functions [1]. In the present study, fermented tapioca used as precursor in CNT synthesis. The liquid part of the fermented tapioca was used with the present of ferrocene as a catalyst, result in the formation of carbon nanotubes at 800 °C in the chemical vapour deposition (CVD) method. The CVD method was chosen because of the type of carbon used, hydrocarbon [2]. The synthesized CNT was then prepared for cells toxicity screening process *in vitro*. The cell lines used is neuroblastoma cells. This is because neuroblastoma cell lines retain the ability of differentiation into neuronal cell types and the ability cells to proliferate as well as to differentiate makes it as excellent in vitro system for various studies [3]. In the present study, the CNT was synthesized at 800 °C by using the CVD method. The product was then characterized by raman spectroscopy, field emission electron microscopy (FESEM), fourier transform infrared spectroscopy (FTIR) and thermogravimetric analysis (TGA). The CNT was then prepared for toxicity test on neuroblastoma cells.

## 2. METHODOLOGY

The fermented tapioca liquid was collected and placed in an immersed heater which was set at 80 °C. Ferrocene (0.25 g, Sigma-Aldrich, Germany) was placed in furnace 1, whereas furnace 2 was left empty.

The synthesis process started at 800 °C in furnace 2, followed by furnace 1 (180 °C), and the immersed heater (80 °C). The synthesis process set for 60 min. The black powder product was characterized by using FESEM (ZEISS Supra 40VP, Germany), TGA (Perkin Elmer Pyris 1, USA), FTIR (Thermo Scientific Nicolet 6700) and raman spectroscopy (Horiba JobinYvon - model DU420A-OE-325).

The CNT were then diluted to a series of concentration ranging from (10 – 500 µg/ml) before subjected to toxicity test. The treatment was set at 24 and 48 h before the 3(4,5-dimethylthiazol-2-yl)-2,5-tetrazolium bromide (MTS) assays was carried out at 490 nm by using GloMax Integrated Multidetection System by Promega, USA.

## 3. RESULTS AND DISCUSSION

The FESEM image showed in Fig. 1is the CNT synthesized at 800 °C looked like spaghetti with a diameter range of 32 - 47 nm. The results of TGA analysis as shown in Fig. 2 revealed that at 650 °C, most carbon-based materials have decomposed and the remaining are the mass attributed to metal catalyst particles. The residual masses are about 30% and the oxidation temperature is 411 °C .The FTIR was used to characterize the functional elements absorbed by CNT. As shown in Fig. 3, the FTIR spectra was in range of 400-4000 $cm^{-1}$. The dominant peak at 462, 541, 1635, 2104 and 3278 $cm^{-1}$.The present of 3278 $cm^{-1}$ peak was assigned for C-H band, the C=C band equal to the peak 1635 $cm^{-1}$.The peak at 3278 $cm^{-1}$refered to C-H band. The microraman analysis result (Fig. 4), showed the indicator for CNT synthesis by the present of G, D and D' peaks at 1582, 1350 and 2690 $cm^{-1}$ respectively is the properties of various raman features in single-walled carbon nanotubes and graphite.For CNT test in vitro (Fig. 5) it showed that the longer CNT left on the cells will cause decrease in cells viability. Carbon nanotubes

showed higher cells death as the CNT concentration increase, however in the present study the CNT at the concentration 100 µg/ml and lower showed higher cells viability compared to test CNT on mixed neuron cells.

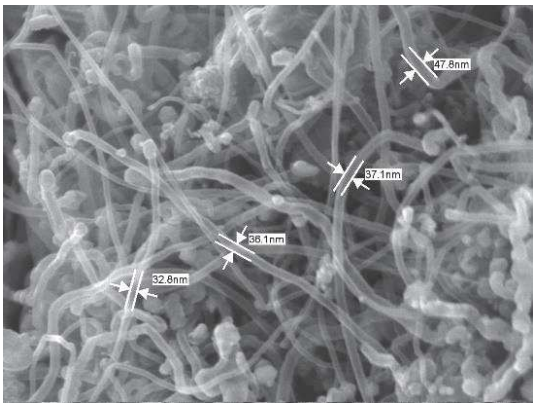


Figure 1 FESEM image of CNT grown with fermented tapioca at 800 °C.

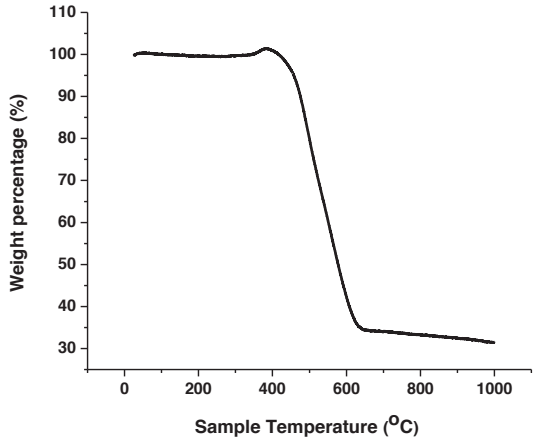


Figure 2 TGA curve of CNT grown with fermented tapioca at 800 °C.

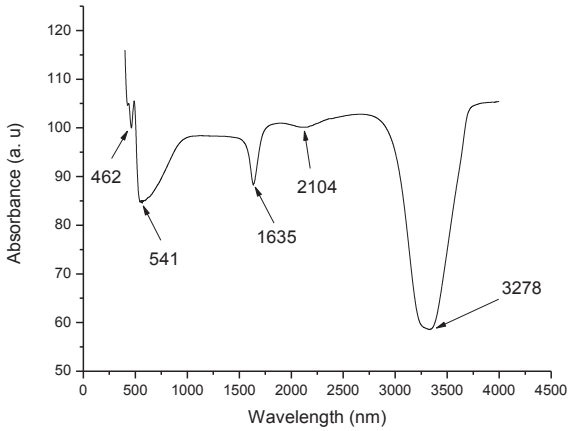


Figure 3 FT-IR spectra of CNT synthesis from fermented tapioca at 800 °C.

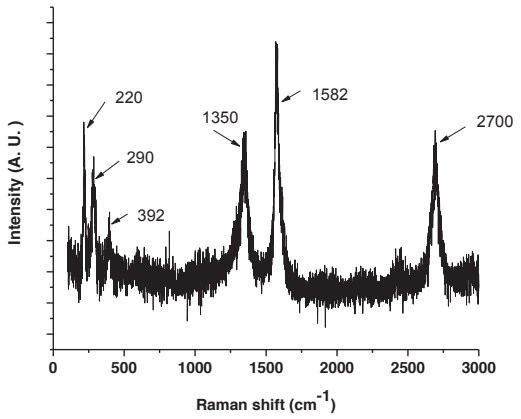


Figure 4 Vibrational spectroscopy of CNT grown with fermented tapioca.

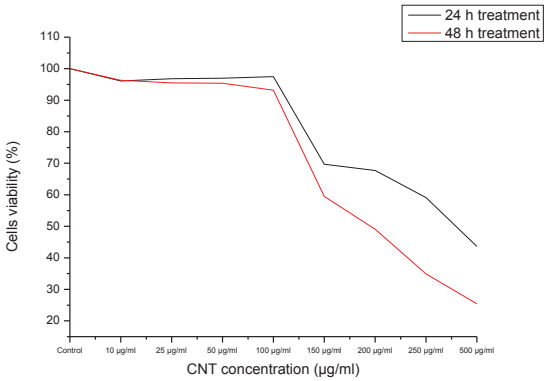


Figure 5 Cytotoxicity screening of synthesized CNT from fermented tapioca on neuroblastoma cells.

## 4. CONCLUSIONS

Successfully synthesized CNT from fermented tapioca (<50 nm). It also showed the characteristic of single-walled carbon nanotube from raman's peak analysis. The cells viability above 80% at 100 µg/ml and lower concentration. This is showed the interaction of CNT with biological systems which might open way to fully explore the CNT potential application for tribological as well as drug carriers.

## 5. REFERENCES

[1] J. Reis, F. Capela-Silva, J. Potes, A. Foncesa, M. Oliveira, S. Kanagaraj, and A. T. Maques, *Carbon nanotubes interaction with biological systems, Carbon nanotubes – growth and applicaqtions*, InTech; 2011.

[2] P. Shastry, A. Basu, and M. S. Rajadhyaksha, "Neuroblastoma cell lines—a versatile in vitro model in neurobiology," *International Journal Neuroscience*, vol. 108, no. 1-2, pp. 109-26, 2001.

[3] J. Prasek, J. Drbohlavova, J. Chomoucka, J. Hubalek, O. Jasek, V. Adam, and R. Kiek, "Methods for carbon nanotubes synthesis-review,"*Journal of Materials Chemistry*, vol. 21, pp. 15872-15884, 2011.