Synthesis of Carbon Nanotubefrom Waste Cooking Oil Catalysedby Mill Scale Waste for Development of Flexible Microstrip Patch Antenna

Ismayadi Ismail[a,*], Muhammad Syazwan Mustaffa[a], Zulkifly Abbas[c], Mohd Nizar Hamidon[a], Intan Helina Hasan[a], Nor Hapishah Abdullah[a]

[a]*Materials Synthesis and Characterization Laboratory (MSCL), Institute of Advanced Technology, Universiti Putra Malaysia, UPM, 43400 Serdang, Selangor, Malaysia*
[b]*Functional Device Laboratory (FDL), Institute of Advanced Technology, Universiti Putra Malaysia, UPM, 43400 Serdang, Selangor, Malaysia*
[c]*Department of Physics, Faculty of Science, Universiti Putra Malaysia, UPM, 43400 Serdang, Selangor, Malaysia*
**Corresponding Author's Email: ismayadi@upm.edu.my*

Abstract: The synthesis of carbon nanotube (CNT) using waste cooking oil (WCO) as green starting material was carried out in a floating catalyst thermal vapor deposition reactor by using millscale waste which is iron oxide nanoparticles (IONP) as a catalyst. Their morphology, composition, mass of substance changes, Raman characteristics and electromagnetic (EM) wave absorption performance were measured by Field Emission Scanning Electron Microscope (FESEM), Energy Dispersive X-ray (EDX), Thermal Gravimetric Analysis (TGA), RAMAN spectroscopy and Vector Network Analyzer (VNA). Results indicated that iron nanoparticles were distributed on MWCNT surface with agglomeration, and MWCNT crucially affected the magnetic properties of iron nanoparticle. Samples which contain higher content of carbon as confirmed by Raman characteristic possess higher absorption value. The enhanced EM-wave absorption performance was mainly ascribed to the increased of interfacial polarization and dielectric loss that resulting from the introduction of MWCNT. The result illustrated that the introduction of MWCNT into magnetic materials can enable the efficient design of excellent patch antenna for wireless communication application.
***Keywords*:** Carbon nanotubes, waste cooking oil, microstrip patch antenna

INTRODUCTION

The dumping of cooking palm oil waste has triggered a major concern over its effect towards the environment. We are looking at the beneficial use of waste cooking oil as the starting material for the synthesis of carbon nanotube (CNT) powder. It will be synthesized via modified chemical vapour deposition (CVD) method by using the injection of waste cooking oil as the carbon source and millscale waste (Fe_3O_4) as the catalyst. CNT exhibit a great range of remarkable properties, including unique mechanical and electrical characteristics have led to the use of CNT as microstrip patch antenna (MPA) in the past few years (1-3). Previous studies have embarked on the usage of carbon fibre composites such as CNT that has caught the interest of many researchers in the attempt to replace metals in antenna. This research intends to explore the application of CNT made from waste cooking oil as a patch antenna and discuss the design and fabrication of these structures and the properties of the acquired antenna

MATERIALS AND METHODS

The methodology of the research work is divided into three stages: (a) Synthesis of carbon nanotube (CNT), (b) preparation of CNT thick film paste and (c) Microstrip patch antenna (MPA) fabrication. During the synthesis, the catalyst used was millscale waste crushed to nanosize powders and waste cooking cooking oil used as the carbon source and argon as carrier gas. The CNT obtained was then characterized. The as-synthesized CNT was further used as an active element in the thick film paste to be fabricated into microstrip patch antenna via screen printing. The microstrip patch antenna was printed onto kapton tape substrate and its return loss and resonant frequency were measured in the frequency range of 1-8 GHz.

RESULTS AND DISCUSSION

The web-like structure consists of nanotube bundles were observed. The bundling results from the attractive Van-der Waals forces between nanotubes.

Fig. 1., the min reflection loss (*RL*) of sample synthesized at 650^{o}C was 12.42 dB at 5.46 GHz. Moreover, sample synthesized at 750^{o}C, the minimum *RL* was 15.97 dB at 3.75 GHz. As for the sample prepared at 850^{o}C, it shows the highest *RL* that is around 27.82 dB at 3.03 GHz. These results revealed that the existence of MWCNT enhanced its EM-wave absorption performance. MWCNT can form conductivity net,and enhance the dielectric loss capability. In addition, the interfacial between magnetite nanoparticles (millscale waste) and CNT enhanced the interfacial polarization capability.

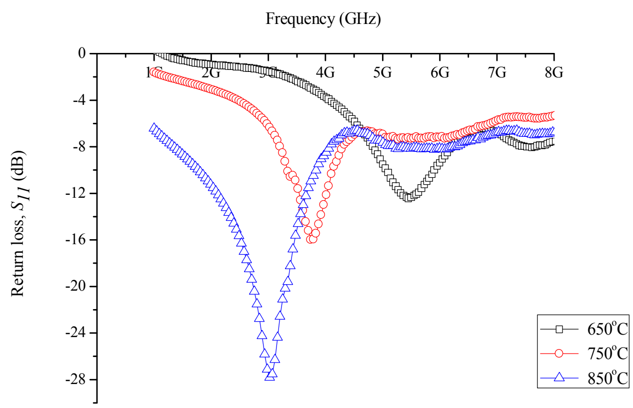

Fig. 1. Reflection loss, S_{11} of MPA at different sintering temperature.

CONCLUSIONS

MWCNT were achieved by using waste cooking oil as a carbon source via modified CVD. Different characterization techniques were used to investigate the formation of MWCNT. FESEM measurements showed that the amount of carbon content can be adjusted by changing the experimental condition. By changing the sintering temperature can result in better properties of CNT that would affect the properties in the electron transport in CNT hence giving better absorption in microwave patch antenna. This study demonstrates that waste cooking oil, a low-cost and readily available resource, can be used as an inexpensive carbon source for the production of CNT and as an active element for microstrip patch antenna.

ACKNOWLEDGMENT: The authors thanked Universiti Putra Malaysia for PUTRA Muda research grant (9545400).

REFERENCES

[1] Baddour CE, Fadlallah F, Nasuhoglu D, Mitra R, Vandsburger L, Meunier JL. *Carbon*, 2008, **47**, 313.
[2] Bhatia R, Prasad V. *Solid State Commun.*, 2010, **150**,311.
[3] Kumar M, Ando Y. *J. Nanosci. Nanotechnol.*, 2010, **10**, 3739.