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Production of Carbon Nanotubes from Coconut Biomass using Microwave Assisted Processes (MAP)

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Abstract: The main objective of this study is to develop carbon nanotubes (CNTs) from coconut biomass using microwave assisted processes (MAP). Preliminary results showed that the bio-oil generated during pyrolysis of coconut shell is mainly composed of phenol; and the other compounds present are phenol derivatives or phenolic compounds which are present in much smaller quantity than phenol. Gases produced during pyrolysis of coconut shell will be used as carbon source in the production of CNTs.

Key Words: Carbon nanotubes; microwave assisted processes, coconut biomass

1. INTRODUCTION

1.1 Production of CNTs

Carbon nanotubes (CNTs) are probably the most well known of nanomaterials. These materials have an interesting class of nanostructure thereby attracted great attention due to their outstanding properties and potential applications. CNTs consists of tubes of graphite-like material closed in on itself to form cylinders with diameters ranging from ~ 1nm up to several nanometers but with length that can approach millimeters or more (Lindsay, 2010). The three (3) widely used methods for CNT production are arc- discharge, laser ablation, and chemical vapor deposition (CVD) methods. Recently, CVD method is commonly used to produce both single-walled and multi-walled CNTs. Plasma enhanced CVD is a novel technology that improved the deposition method due to the presence of charge species and radicals under the electronic field.

Researchers across the globe have used various types of carbon sources for CNTs growth by catalytic CVD and most commonly used are methane, acetylene, ethane, benzene, ethylene, xylene, carbon monoxide, isobutane and ethanol. Besides, other organic compounds, particularly polymers, carbonization of polyacrylonitrile, poly-furfuryl-alcohol, and amino-dichloro-s-triazine have been successfully used for growth of CNTs. The natural carbon sources for CNT synthesis are camphor, turpentine oil, eucalyptus oil, castor oil, coconut oil and palm oil (Shah and Tali, 2016).

2. METHODOLOGY

In this study, CNTs were produced via chemical vapor deposition- microwave enhanced process. The microwave set up and reactor used in this study is shown in **Figure 1**. A metallic washer was used as substrate for the catalyst. Nickel thin film was employed as the source for nanoparticle catalyst. It uses pencil lead made from graphite as emitter. A Whirlpool AVM-585 domestic microwave oven was used in this experiment with an input power of 1,350 W and magnetron output power of 850 W. The reactor was made from quartz glass which can withstand high temperatures. The carbon source used in this set up are the gases generated from the pyrolysis of coconut shell.

A

B

Fig. 1. (A) Microwave set up and (B) Reactor

A simple microwave-assisted pyrolysis setup with one condenser was assembled to test the feasibility of coconut shell pyrolysis in a microwave reactor under vacuum conditions. The MAP schematic diagram is shown in **Figure 2**.

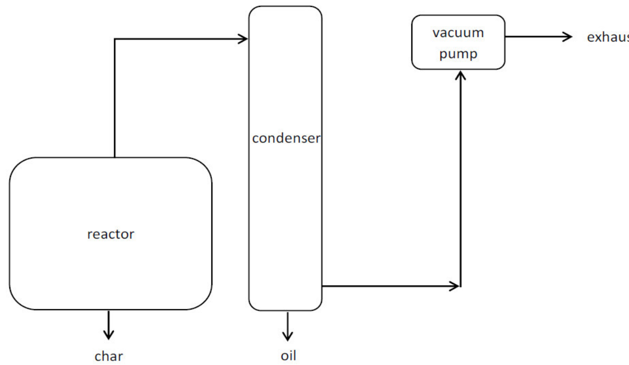

Fig. 2. Microwave Assisted Process

In this set up as shown in **Figure 3**, the reactor consists of a ceramic mortar placed inside a desiccator with a stopcock that functions as an outlet of the gases produced in the pyrolysis. The coconut shell was heated using microwave radiation at full power for 30 minutes. The condensable gases produced were condensed and collected (bio-oil). Some of the gases condensed in the sides of the desiccator.

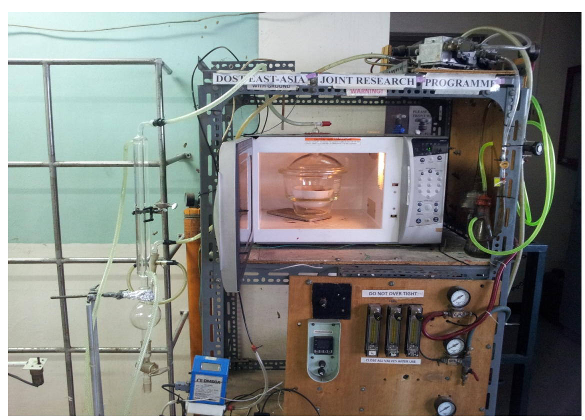

Fig. 3. Experimental Set-up

Bio char and CNTs produced were characterized using SEM, EDX, FTIR and TGA analyses. Meanwhile, bio-oil generated during the pyrolysis of coconut shell was characterized using GC-MS.

3. RESULTS AND DISCUSSION

The surface image of the bio-char was characterized using SEM as shown in **Figure 4**.

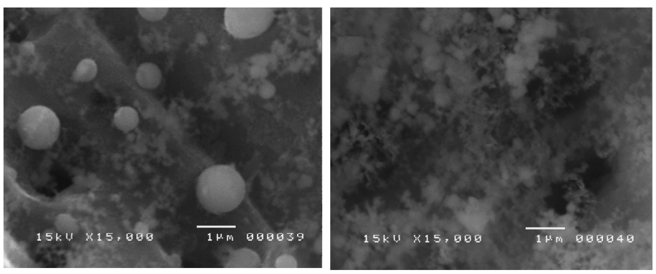

Fig. 4. SEM images of Biochar

Meanwhile, the compounds present in the bio-oil were identified using GC-MS. The mass spectra of compounds (see **Figure 5**) separated in the gas chromatograph were matched to the database of mass spectra. It was found that the bio-oil is mainly composed of phenol; and the other compounds present are phenol derivatives or phenolic compounds which are present in much smaller quantity than phenol.

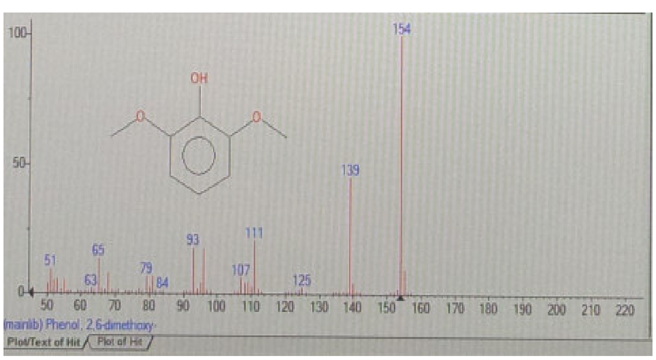

Fig. 5. GC-MS Result

4. CONCLUSIONS

Preliminary results showed that bio-oil generated during pyrolysis of coconut shell is mainly composed of phenol; and the other compounds present are only phenol derivatives or phenolic compounds which are present in much smaller quantity than phenol.

5. ACKNOWLEDGMENTS

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6. REFERENCE

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