Physical and Dielectric Properties of Palm Shell Biochar

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***Abstract*— Biochars were prepared from palm shell by heating at different temperatures in the muffle furnace. The chars were studied by scanning electron microscopy (SEM) and fourier transform infrared spectroscopy (FTIR) to investigate morphology and composition of biochars. The biochars were pelletized into pellets and the values of dielectric constants were measured using LCR Digibridge meter. The porous nature and high dielectric values of palm shell biochar were observed.**

***Keywords*— Palm Shell; Biochars; Muffle Furnace; Porous Nature ;**

I. INTRODUCTION

Biochar is a solid residue obtained during the thermal conversion of biomass into fuel product and has been treated as a lower value byproduct compared to higher valued syngas and bio-oil [1]. It is produced from biomass compound that undergo controlled pyrolysis/gasification in the absence of oxygen under temperature ranging from 300˚C to 1000˚C[2]. Biochar can contribute to many application. Soil improvements attributed to the addition of biochar include increased moisture retention, improved air permeability, elevated cation exchange capacity, increased buffering of soluble organic carbon, and synergistic interactions with soil microbial populations[3]. Biochar is garnering significant attention in recent years as a significant tool for environmental management[4]. Biomass provides us with timber, food, feed, fiber, and energy. World demand for electricity is directly related to humans increasing need for energy. Development of new energy generation technologies to satisfy those needs is increasing as well. Current use of biomass for energy including industrial steam production and residential heating could contribute a great deal to global warming and particulate pollution if directly burned[5]. Up to date, coal burning is one of the most common methods used to generate electricity. This method produces greenhouse gases especially CO2, which is the major cause of global warming. In addition to CO2 generation, some varieties of coal release significant quantities of sulfur dioxide, which leads to acid rain. Various other impurities in coal, such as mercury (which is highly toxic) are also released in the air[6].

In response to the changing global landscape, energy has become a primary focus of the major world powers and scientific community. There has been great interest in developing and refining more efficient energy storage devices. One such device, the supercapacitor, has matured significantly over the last decade and emerged with the potential to facilitate major advances in energy storage[7]. It is postulated that any porous, electrically insulating material (e.g., high surface area powders of silica, titania, *etc.*), filled with a liquid containing a high concentration of ionic species will potentially be an super dielectric material[8].

This paper aimed at characterizing physical and dielectric properties of of palm shell biochar prepared by heating at different temperatures (200˚C,400 ˚C,600 ˚C,800 ˚C,1000 ˚C) for 2 hours.

II. EXPERIME PROCEDURE

A. Preparation of the Biochar

Palm fruit, coconut and betel nut were collected. They were washed with fresh water to remove dirt. After that, the shells (mesocarp fibers) were taken. They were dried in the sunshine. The dried shells were cut into small pieces and heated in the muffle furnace. The heating conditions are at 200˚C, 400˚C, 600˚C,800C and 1000˚C for 2hours. The biochar samples were pelletized by pressing with pelletizer.

B. Characterization Methods

Surface morphology and composition were characterized using scanning electron microscopy (JSM-5610 LV SEM system) and fourier transform spectroscopy (FTIR).

The dielectric properties of samples were measured using LCR Digibridge meter (Digital Impedence Analyzer) over the frequency range between 1kHz and 100kHz. The lower frequencies of 100Hz and 120Hz were also used.

III. RESULTS AND DISCUSSION

A. SEM analysis

Scanning electron micrographs for external morphology of palm shell bio-char at temperatures 200ºC, 400ºC, 600ºC, 800ºC and 1000ºC for 2h were shown in Fig 1.

From SEM images, it is found that the surface morphology of biochar changes with temperature.

From Fig, there were longitudinal sheets of pyrolysized precursor in 200ºC biochar. It forms the flaked layers. At 400 ºC, the pores of about 10μm diameter were found on some region and there were also flaked layers. The pore area became larger in 600 ºC biochar. At the higher temperature of 800 ºC, the pore walls were crushed into pieces and void spaces were formed among them. The crushed pieces were distributed uniformly. They were irregular in size. In 1000 ºC palm shell biochar, the crashed pieces became smaller due to heat treatment.

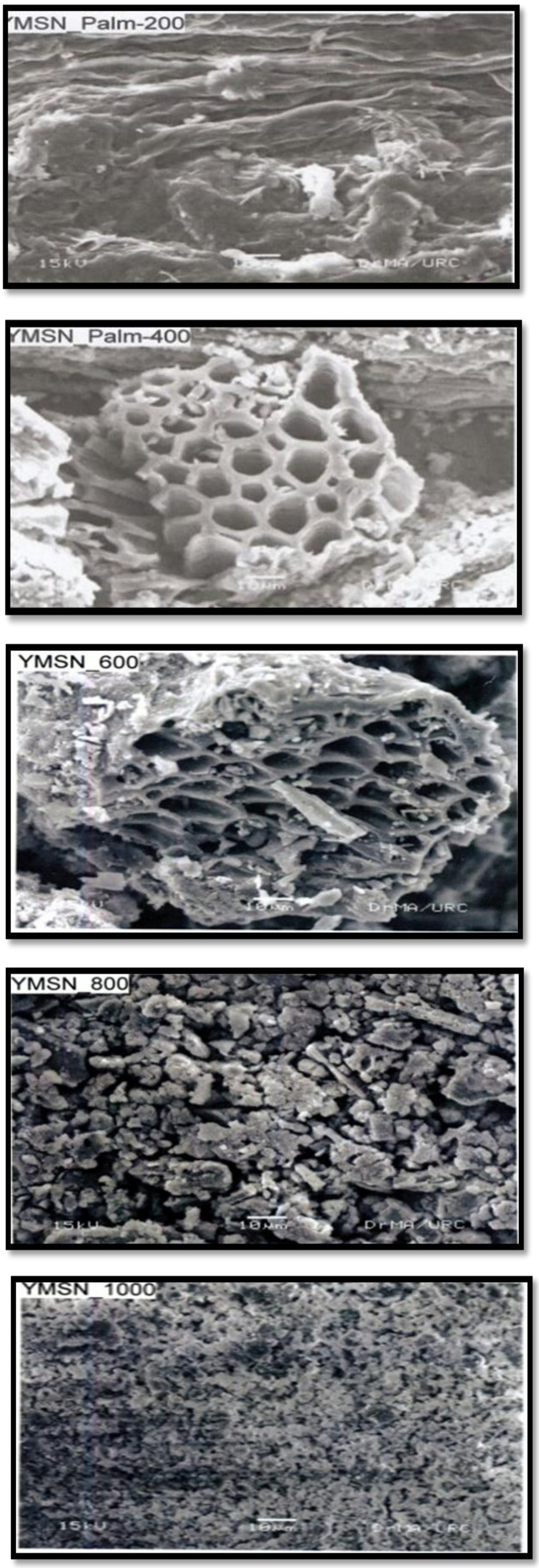

Fig.1. SEM images of palm shell biochars

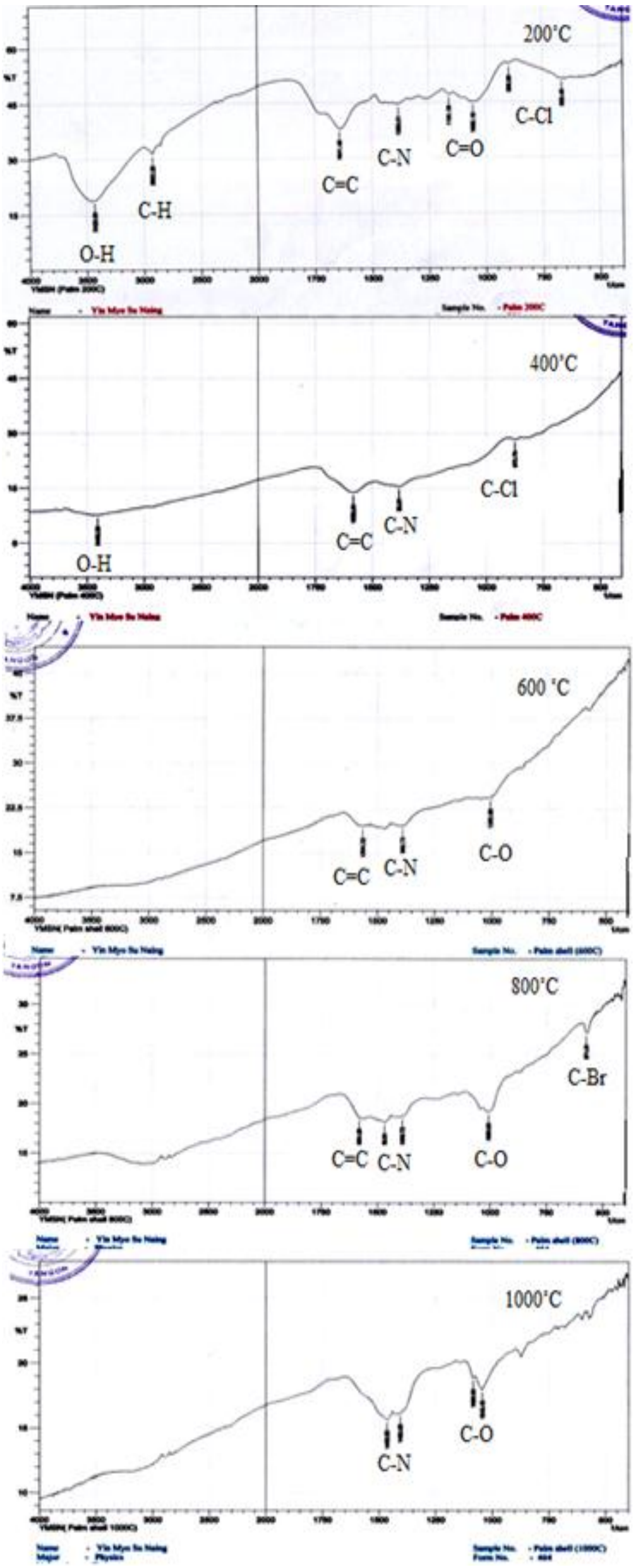

Fig.2. FTIR spectra of palm shell biochars

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FTIR analysis

Fig.2. shows FTIR spectra of palm shell biochar at different temperatures. O-H stretching H bonded vibration of alcohol and phenol peaks were observed at 200 ºC and 400 ºC. At higher temperatures, these peaks disappear which indicate dehydration. C-N stretching vibration and C=C stretching vibration were formed at all temperatures. From the observation, an elevating temperature from 600 to 800ºC generated an increase in characteristic bands, 1500-1400 cm^{-1} (aromatic C=C stretching mode) and bands between 1000 and 1100 cm^{-1}(C-O stretch and C-N stretch).

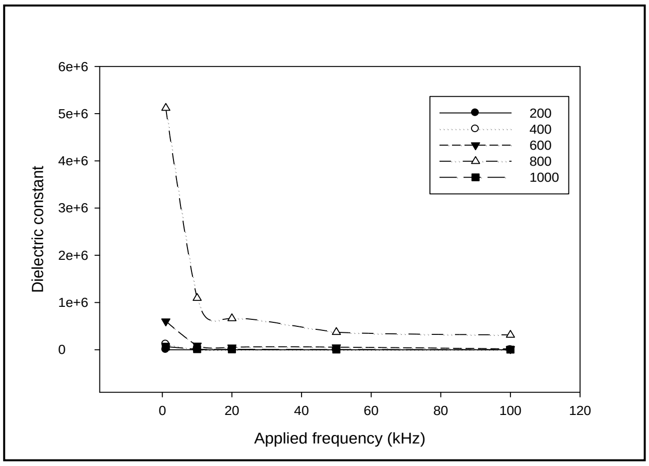

Fig.3. Frequency dependence dielectric constants

TABLE I DIELECTRIC CONSTANTS AT LOW FREQUENCIES

Temperatures(˚C)	Applied frequency (Hz)	
	100	*120*
200	42.5	53.1
400	1.39E+06	1.70E+06
600	3.03E+06	2.80E+06
800	1.18E+07	1.50E+07
1000	3.76E+05	3.47E+05

B. Dielectric properties

Fig.3. shows the effect of frequency on the dielectric properties of palm hell biochars prepared at different temperatures. The dielectric constants were generally decreased with an increase in applied frequency. The dielectrics of the biochar heated at 200˚C were small. The high dielectric constants were observed in biochars heated from 400 ˚C to 1000 ˚C.

From table I, the dielectric constants were very high at the low applied frequency of 100Hz and 120Hz for temperatures from 400˚C to 1000˚C

The content of carbon was found from FTIR spectra. The high dielectrics at low applied frequencies were evaluated from LCR measurement.

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IV. CONCLUSION

The porous nature of palm shell biochar was observed from heating temperatures from 400 ˚C to 1000˚C. This was consistent with electrode materials which need to be porous.