Synthesis and Characterization of Cocoa Pods Waste Carbon for Radar Absorber Material

by Ananda Putra

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Abstract— Synthesis and characterization of Radar Absorber Material (RAM) has been done. The raw material of the carbon is waste cocoa pods as dielectric material. An activated carbon of waste cocoa pods has porous and large inner surface that has high absorbency and can be implemented as alternative RAM. The carbon was prepared using carbonization and activated using chemicals activator KOH and HCL. The active carbon is characterized using a Vector Network Analyzer (VNA) to investigate the return loss for variation of the thickness of the material in the frequency range 4 to 8 GHz (C-band). Morphology characterization is performed using Scanning Electron Microscopy (SEM). The experiment result obtain the maximum absorption of the developed carbon is −14.0 dB at 8 mm thickness with 1 M KOH activation substances. The result shows the reflectivity response of the carbon is satisfied in the frequency range of studied. The SEM measurement present the activated carbon has more porous compare to a non activated carbon. Based on this study, a carbon active of waste cocoa pods can be used as a RAM.

1. INTRODUCTION

The radar technology is operated to detect distant objects using the beam or electromagnetic waves [1]. Radar Absorbent Material (RAM) is the most important part in the development of radar technology. RAM is used in a wide range of telecommunication industry applications to eliminate stray or unwanted radiation that could interfere with a system's operation [2]. They can also be used to recreate a free space environment by eliminating reflections in an anechoic chamber [3]. Development of the radar absorbers have been developed covering the technology of materials and design of the absorber. In the research technology of absorbent, the expensive radar absorbers have been developed [4]. On the other work, the development of radar absorber of carbon-based materials has also been made in the limited working frequency and narrow bandwidth [5, 6].

There are some methods that can be used to increase the absorption of radar waves, among others, fill it with some type of material as filler, engineering design and the structure of the coating, as well as variations in the thickness of the coating. An addition, the low cost material can be obtained using certain waste material in local resources. The material is developed to obtain the satisfy reflection coefficient or return loss (RL) at the targeted working frequency [7].

In this work, the low cost radar absorber based on waste cocoa pods material is investigated. Utilization of the waste cocoa pods is still very limited, so that the economic value obtained from utilization is still low enough. A fairly high content of cellulose on the pods of cocoa can be used as an alternative to RAM materials [8]. The pods of cocoa are carbonized and activated using chemical method using HCL and KOH. Activated carbon is one of the absorber that effectively used in absorption processes. Activated carbon has an amorphous crystalline structure, the large surface area and has the number of pores. The pores in the activated carbon are very well utilized as an absorption medium, especially on the RAM [9].

This research was conducted to find out the relationship of the carbon absorber based on cocoa pods and variation of absorber thickness, activator, and concentration of the activator. Activated carbons are characterized using VNA to investigate the wave absorption of the RAM. The SEM instrument is performed to observe the microstructures of the developed RAM.

2. METHODS

2.1. Carbonization of Waste Cocoa Pods

Waste pods of selected cocoa are cleaned from sticky seed or fibers containing on the pods of the cocoa. Furthermore, cocoa pods dried to reduce the levels of water in order to produce a good carbon. Carbonization of cocoa pods is done by Pyrolysis (burning) of materials containing carbon. Carbonization results mashed using a blender and sifted using 100 mesh filters. The filtered carbon is activated chemically using HCL and KOH with variation concentration (M). After being washed, the material is neutralized using aquades. The material is dried in an oven at a temperature of 110° for 2 hours and an activated carbon powder is obtained.

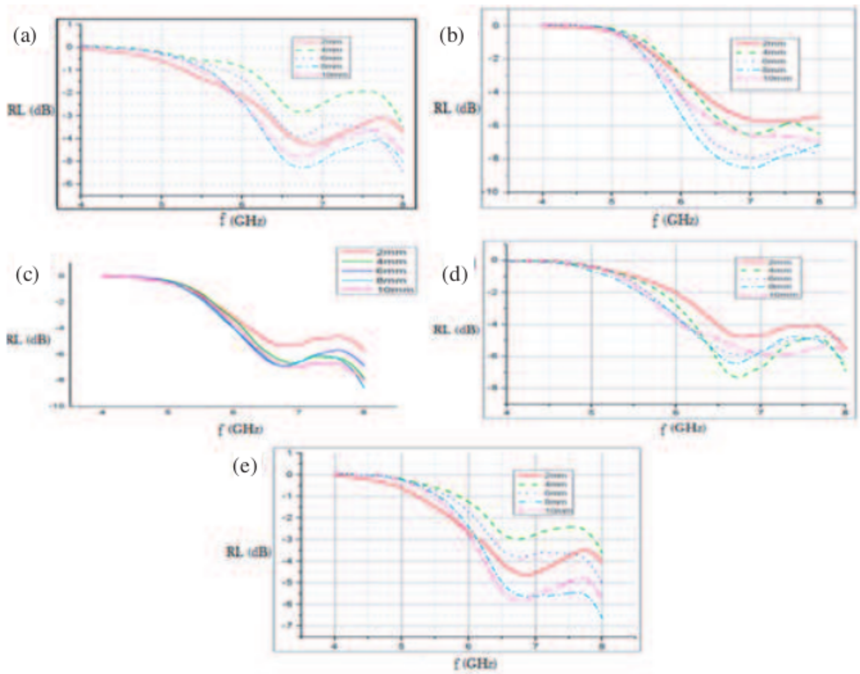


Figure 1: The relationship reflection coefficient and frequency using KOH activator for a variation of the material thickness and concentration of KOH (a) 1 M, (b) 2 M, (c) 3 M, (d) 4 M and (e) 5 M.

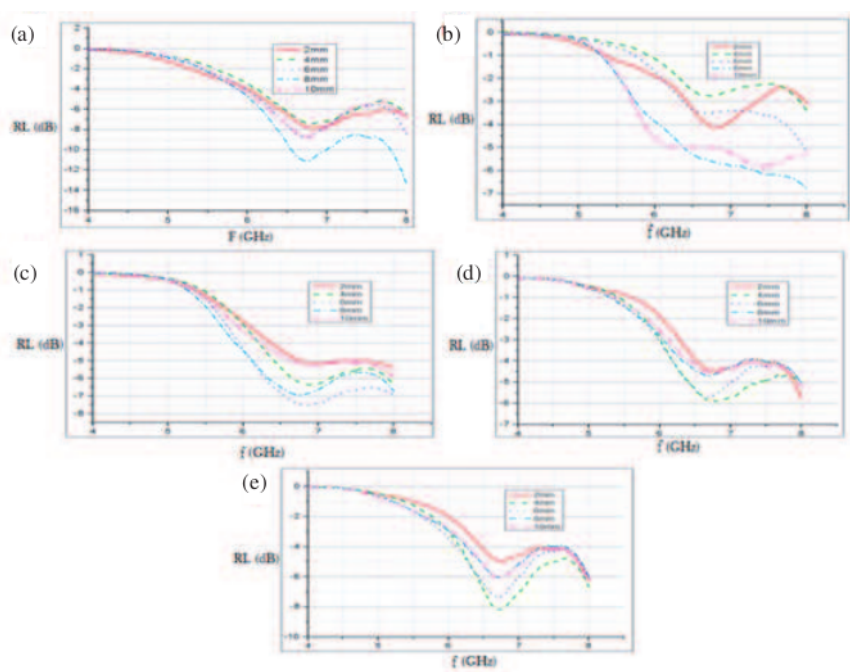


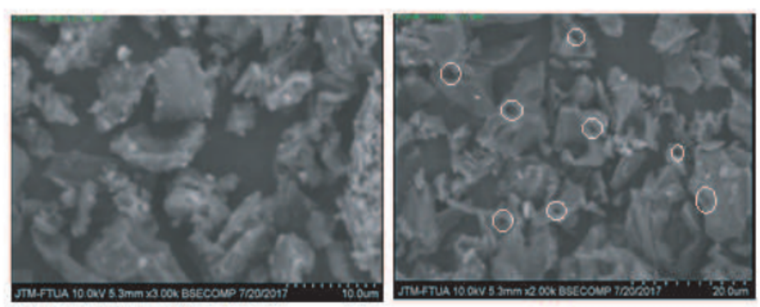
Figure 2: The relationship reflection coefficient and frequency using HCL activator for a variation of the material thickness and concentration of HCL (a) 1 M, (b) 2 M, (c) 3 M, (d) 4 M and (e) 5 M.

2.2. Characterization

A VNA is performed to measure the absorbance of the material that has been activated. Measurements of absorbance is done by attaching the material to an acrylic mold with a thickness of 2 mm, 4 mm, 6 mm, 8 mm, and 10 mm. The material that has maximum absorber is investigated using a Scanning Electron Microscopy (SEM) to capture the microstructures of the absorber material.

3. RESULTS AND DISCUSSION

The relationship of the return loss (RL) of the material with the frequency for thickness variation using KOH activator is plotted in Figure 1. Furthermore, the characteristics of the material using HCL activator are plotted in Figure 2. Based on Figure 1, the maximum value of RL is obtained of −14.0 dB at a frequency of 8 GHz and 8 mm thickness with a concentration of 1 M. The graph also present the working frequency of the material is beyond the C-band. The reflection coefficient of the activated carbon material is not linear with the concentration of the activator. The low absorption of the material is obtained for the concentration of the activator more than one. It is probably due to the overlap pores on the carbon surface and destroys the absorber. For HCL activator, the maximum absorbance of the material is 8.4-dB on frequency 8 GHz, 4M concentration and thickness of 6 mm. The absorption of the material activated using HCL lower than material activated using KOH. This probably the KOH activator can reduce other ingredients better. The microstructures of the carbon can be observed using a SEM. The observations of carbon of cocoa pods for both before and after activated can be seen in Figure 3. Compare to the non activated carbon, the activated carbon has a much more porous. The number of pores on the surface of the carbon can improve the microwaves absorption on the carbon material.



(a) (b)

Figure 3: Morphology of waste carbon cocoa pods; (a) before activated and (b) after activated.

4. CONCLUSION

The characteristics of cocoa pods waste carbon have been studied for radar absorber material. The return loss of the carbon material using VNA has been investigated. The experiment results demonstrate the maximum return loss of the absorber of −14.0 dB at 8 mm thickness and 1 M KOH activator concentration. A SEM instrument is operated to clarify the surface morphology of the developed carbon. An activated carbon has a much more porous compare to the non activated carbon and contribute to the microwave absorption on the material. Based on this investigation, the carbon active of the waste cocoa pods can be used as a RAM.

REFERENCES

1. Lillesand, T. M. and R. W. Kiefer, *Remote Sensing and Image Interpretation*, John Willey and Sons, New York, 1979.
2. Laird Technologies, "Microwave absorbing materials," 2006.
3. Dixon, P., "Theory and application of RF/microwave absorbers," Emerson & Cuming Microwave Products, Randolph, 2012.
4. Yew, B. S. and F. H. Wee, "Agricultural waste based-coco peat microwave absorber," *International Journal of Engineering Sciences & Emerging Technologies*, Vol. 7, No. 2, 547–554, 2014.

5. Kaur, R. and G. D. Aul, "Review on microwave absorbing material using different carbon composites," *International Journal of Engineering Research & Technology (IJERT)*, Vol. 3, No. 5, May 2014.
6. Malek, F., H. Nornikman, and O. Nadiah, "Pyramidal microwave absorber design from waste material using rice husk and rubber tire dust," *Journal of Telecommunication, Electronic and Computer Engineering*, Vol. 4, No. 1, 23–30.
7. Tsay, C. T., et al., "Investigation on electromagnetic and microwave absorbing properties of La0.7Sr.MnO3/carbon nanotube Composites," *Journal of Applied Physics*, Vol. 107, 09A502, 2010.
8. Anas, S., A. Zubair, and D. Rohmadi, "Kajian pemberian pakan kulit kakao fermentasi terhadap pertumbuhan sapi bali," *Jurnal Agrisistem*, Vol. 7, No. 2, 79–86, 2011.
9. Menendez, J. A., A. Arenillas, B. Fidalgo, Y. Fernandez, L. Zubizarreta, E. G. Calvo, and J. M. Bermudez, "Microwave heating process invloving carbon materials," *Journal of Fuel Processing Technology*, Vol. 91, No. 1, 1–8, 2010.

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