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ICE-CREAM STICKS PYRAMIDAL ABSORBER

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ABSTRACT

This paper is concerned on designing and determining the absorption effect of ice-cream sticks pyramidal absorber (ISP absorber). The basic microwave absorber was design by cutting ice-cream sticks into pyramidal shape. In this paper, there are two type of ISP absorber which are coated with palm ash as absorbent material and without coated with absorbent material respectively. The absorption performances are analyzed and simulated by using CST Microwave Studio. The absorber was measured by using arch method for microwave frequency range of 8 GHz to 12 GHz in order to determine the absorption performance. Measured results showed absorber coated with palm ash produced the best performance in terms of signal absorption. This absorber promised green technology and low cost with reliable performance for various communication applications such as anechoic chamber.

Keywords: absorbent material, microwave absorber, ISP absorber, green technology, ice-cream sticks.

INTRODUCTION

Due to rapid growth in communication industry, human are exposed too much to the electromagnetic radiation. The absorption of electromagnetic energy by human body may disorders the brain activity and reduce its concentration (Regel, S. J. and P. Achermann, 2011). In order to reduce the exposure to electromagnetic energy, microwave absorber was introduced (S. Isha, M. Najim, P. Smitha, D. Singh and G. D. Varma, 2014). Absorbers are used to eliminate unwanted radiation or reflections in an anechoic chamber. Commercial microwave absorber was made from ferrite tiles (NiZn), polystyrene, polyethylene and polyurethane (Ben Smythe, Sean Casserly and Dean Arakaki, 2014) which is costly and not environmental friendly. In order to reduce the cost yet better performance with safer material, this project comes out with the idea to replace the current absorber material with ice-cream stick.
Like others developing countries, Malaysia also facing an increase of waste per day. About 95% of total wastes are sent to landfills for disposal (Fauziah S. H and Agamuthu P, 2010). These wastes is harmful to environment and public health. The way to reduce these negative impact, the waste must be recycled, composted or reused. Green biomass absorber is an idea of inventing a microwave absorber by using agricultural waste as the main material to absorb microwave radiation.

Carbon is the important element to absorb microwave signal in the microwave absorber. Agricultural waste have a potential to be used as a material for microwave absorber because activated carbon is found in the biomass waste such as palm ash, coconut husk, corn and rice husk (Ben Smythe, Sean Casserly and Dean Arakaki, 2014),(Y. S. Lee, F. Malek, E. M. Cheng, W. W. Liu, F. H. wee, M. N. Iqbal, Z. Liyana, M. N. A Karim and M. F. Haji Abd Malek, 2013). In this project, palm ash as shows in Figure-1 is used as a main material in designing the ISP absorber. Palm ash contains 46.5% of carbon (Mohd Basri Wahid, 2008). It can help to attenuate the microwave signal that pass through the palm ash.

Figure-1. The palm ash in powder after going through process of heating in the absence of air.

METHODOLOGY

Figure 2 shows the flow for the proposed microwave absorber. In this part, the procedure of designing and developing ice cream stick absorber is explained. At first, ice cream stick is cut into pyramidal shape. Then ISP absorber performance will be measured under arch method. On the other hands, the palm oil waste is burned to get the palm ash. After that, palm ash will be mixed with green paint and coated to the ISP absorber. Next, the performance of absorber which is coated with palm ash is measured by using arch method.

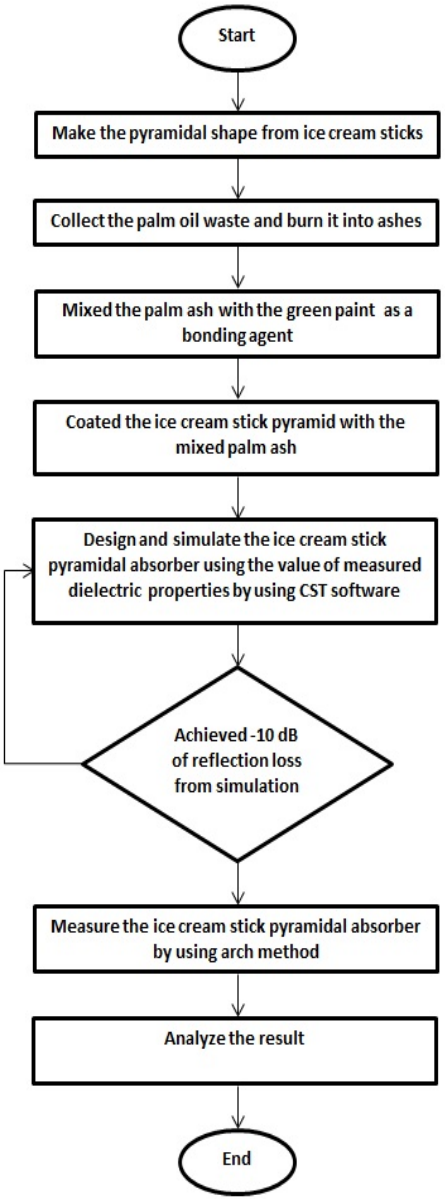

Figure-2. Development of ice cream stick pyramidal absorber.

The arch method was conducted in order to determine the performance of ISP absorber for the frequency range of 8 GHz to 12 GHz as shown in Figure-3. The procedure begins by measure the reflection of a metal plate at the center of the arch. Only then the ISP absorber is placed above the metallic plate to measure its reflection. The reflection coefficient is considered as the ratio of the sample reflection to the metal plate reflection.

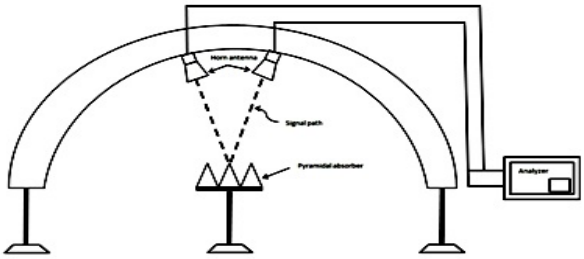

Figure-3. Arch method.

ABSORBER DESIGN

The ice-cream sticks biomass absorber was design to be operating in the frequency range from 8 – 12 GHz. The absorber designs basically considered the shape of the absorber as it affect the performance of the absorber. The pyramidal shape was chosen since its performance has been proved to work at microwave frequency (H. Nornikman, P. J. Soh, A. A. H. Azremi and H. M. R Nurul, 2010),(F. Malek, Z. Liyana, F. H. Wee and H. Nornikman, 2012),(Imran Mohd Ibrahim, Nur Massyitah Yaakob, Mohd Nor Husain, Sian Meng Se and Azizah Shaaban, 2011) and mostly installed in anechoic chamber. Figure 4 shows the geometry of the proposed absorber. The dimension one pyramidal shape is 8cm width x 8cm length x 15cm height. While the dimension of the base part is 48cm x 48cm x 4cm. To form an absorber, 36 pieces pyramid is required. Figure 5 indicate the ice cream stick biomass absorber in CST Microwave Studio simulation.

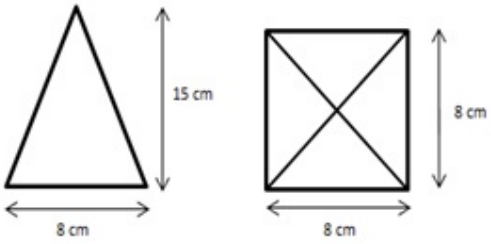

Figure-4. Dimension of pyramidal shape.

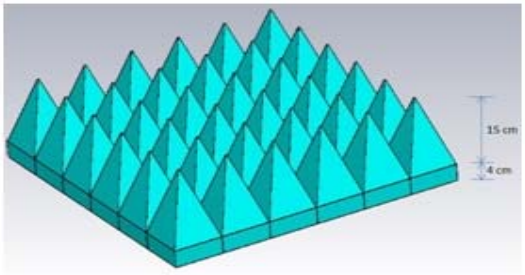

Figure-5. Ice-cream sticks biomass absorber designed in CST microwave studio.

For the fabrication process, ice cream sticks was cut into pyramidal shape and then coated with palm ash (biomaterial activated carbon). The palm ash powder has

been mixed with green paint as an adhesive agent. Figure-6 shows the single unit of the ice cream stick pyramidal absorber after coated with the palm ash.

Figure-6. Single unit of ISP absorber coated with palm ash.

RESULTS AND DISCUSSION

Simulation Result

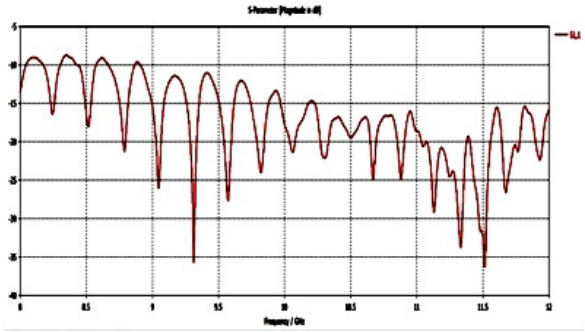

Figure-7. Simulation result of ice cream stick absorber.

The simulation result from CST Microwave Studio is shown in Figure-7. From the observation, the signal absorption at frequency 8 GHz is –14 dB, at frequency 9 GHz and 10 GHz the absorption is – 17 dB, at frequency 11 GHz the signal absorption is – 19 dB and at frequency 12 GHz gives – 16 dB absorption signal.

Measurement result without coated palm ash

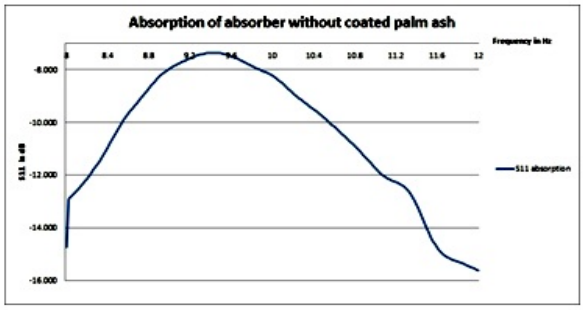

Figure-8. Measurement result without coated with palm ash.

The S11 of fabricated ISP absorber is measured by using arch method. The measurement was done for two type of absorber, without coated with palm ash and coated with palm ash. The measurement result without coated with palm ash is shown in Figure-8. It can be seen that from the frequency of 8 GHz to 12 GHz, there is absorption happened even though the absorber not coated with the absorbent material. Ice cream stick that been used in this work are made from rubber wood. Researcher has been proved that there is 43.27% carbon contained in the rubber wood (A. Shaaban, Sian-Meng Se, Nona Merry M. Mitan and M. F. Dimin, 2013). The highest absorption happened at frequency 12 GHz with –15 dB. The average absorption of the absorber is –7 dB.

Measurement result coated with palm ash

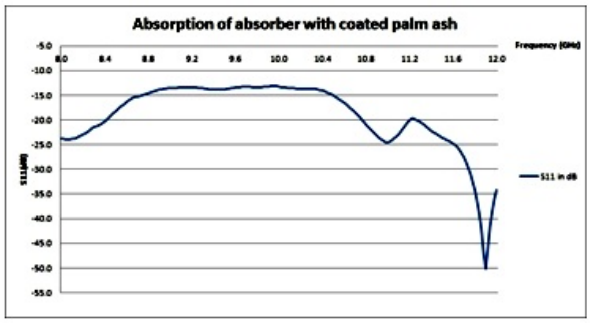

Figure-9. Measurement result coated with palm ash.

The measurement result of coated palm ash absorber gives better absorption as shown in Figure-9. The absorption is achieved at – 24 dB at frequency 8 GHz, – 14 dB at frequency 9 GHz and 10 GHz, – 25 dB at frequency 11 GHz and – 35 dB at frequency 12 GHz. It can be seen that the S11 of the ISP absorber coated with the palm ash increased. The S11 absorption at frequency 12 GHz achieved 54.3% better than without coated the palm ash.

CONCLUSIONS

For the conclusion, the environmental friendly and economic pyramidal microwave absorber can be developed by using ice cream stick and palm ash as the main material. In this work, ice cream stick pyramidal absorber coated with palm ash shows the better absorption result. It's proved that carbon which is found in the palm ash can enhance the absorption performance of ISP absorber. The S11 absorption of ISP absorber at frequency 12 GHz achieved – 35 dB better than without coated the palm ash.

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