Experimental the Microwave Absorption of Rice Husk/Ash Mixture

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Abstract— This paper is to study the performance of rice husk and rice husk ash (RH-RHA) mixture material as a microwave absorber. The microwave absorption and dielectric properties, ε of RH-RHA mixture with different ratio were investigated in microwave frequency region 8.2 to 12.4 GHz (X-band). A waveguide transmission line method (Nicholson-Ross-Weir) was used to measure the complex permittivity of RH-RHA with different weight ratio mixture. The RH-RHA microwave absorbers were designed and simulated in CST-MWS. The various ratio RH-RHA mixtures show the different dielectric properties and the microwave absorption was investigated. The 60%RH-40%RHA microwave absorber has the best microwave absorption 46–76%.

1. INTRODUCTION

Rice is producing the crop in the form of rice husk (RH), where the rice husk ash (RHA) is the byproduct of RH that is obtained after burning rice husks in furnace or open air. Open air burning the RH at the paddy field causes environment pollution. The RH can be reused and applied in microwave absorber application [1–3]. The RH and RHA are lossy material due to their unique dielectric properties. The dielectric constant, ε_r' is the ability of a material to store electromagnetic wave [4–6]. The loss factor, ε_r'' is the ability of the material convert the electromagnetic wave into heat and dissipated [7, 8]. The dielectric properties of a material are important in microwave absorption. In this work, the RHA have been investigated as the material for the microwave absorbers. The microwave absorption of the rice husk and rice husk ash mixture (RHA) was investigated in various ratio mixtures.

2. EXPERIMENTAL

The raw RH and RHA were mixed with polyester and methyl-ketone-polymer. The RH and RHA were composites with different ratio. Table 1 shows the ratio of the RH and RHA composites. The RH was composite with difference amount of RHA from 20% to 60% of weight ratio.

Table 1: Rice husk/rice husk ash ratio (%total weight).

Sample code	Rice Husk (%)	Rice Husk Ash (%)
RA82	80	20
RA64	60	40
RA46	40	60

The fabricated samples were fabricated in a rectangular shape with 5 mm thickness which fit into the samples holder. Figure 1 shows the Fabricated samples and sample holder. The complex relative permittivity or dielectric properties ($\varepsilon_r = \varepsilon_r' - j\varepsilon_r''$) of RH-RHA composites were measured using rectangular waveguide and Agilent 85071E software over 8.2–12.4 GHz frequency range.

3. SIMULATION

The dielectric properties of the absorbing materials are the basic parameters. The results of different RH-RHA samples are simulated using Computer Simulation Technology (CST) Microwave Studio

(a) (b)

Figure 1: (a) Fabricated samples and (b) sample holder with sample.

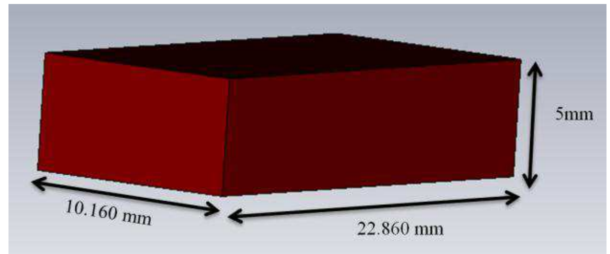


Figure 2: Samples dimension in CST.

software. Before simulate the result, the sample must be defined the dielectric constant and loss factor in CST-MWS over 8.2 GHz–12.4 GHz frequency range. In this simulation, the RH-RHA samples were simulated with metal backed plate. The RH-RHA microwave absorber has been designed and simulated in CST-MWS. The various ratio RH-RHA mixtures show the different dielectric properties and the microwave absorption. The microwave absorption was calculated by Equation (1) [9, 10];

$$A(\%) = \left[1 - (S_{11})^2\right] \cdot 100\% \tag{1}$$

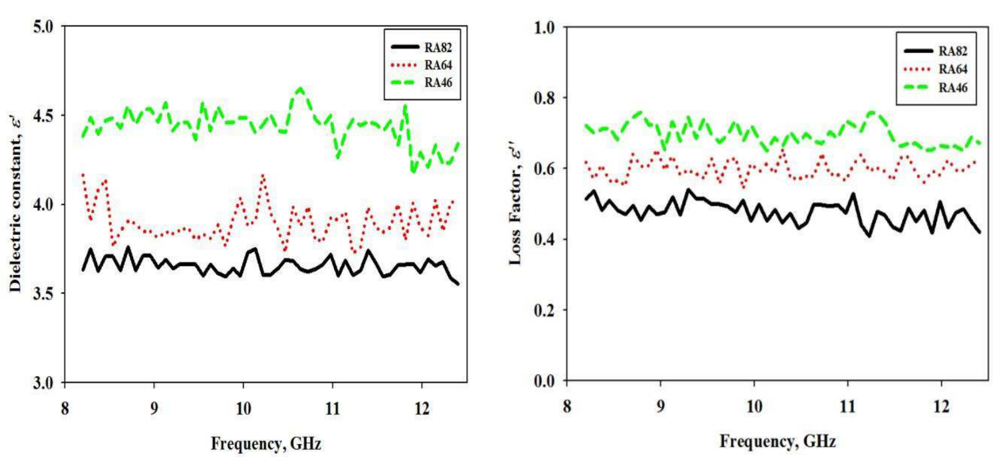
where $A(\%)$ and S_{11} are the percentage of absorption loss and reflection loss. The microwave absorbers do not absorb any microwave the entire signal if the microwave absorber unable to absorb microwave and the $A \cong 0\%$. The performance of RH-RHA samples can obtained using CST microwave studio [11]. Figure 2 shows the sample dimension designed in CST microwave studio.

4. RESULTS AND DISCUSSION

4.1. Dielectric Propeties

The dielectric constant and loss factor result are shown in Figures 1(a) and (b). The various ratio RH-RHA mixtures show the different dielectric properties of RA82, RA64, and RA46. From Figures 1(a) and (b), the dielectric constant and loss factor were increased by increasing the ratio of RHA in the composition. For samples RA82, the values of dielectric constant and loss factor are 3.6–3.7 and 0.43–0.57 respectively. The dielectric constant and loss factor of samples RA64 is 3.7–4.2 and 0.57–0.65 respectively. The sample RA46 has the highest dielectric constant values 4.1–4.7 and 0.65–0.79 over 8.2–12.4 GHz frequency range.

When the ratio of RHA increase from 20% to 60%, the dielectric constant and loss factor



(a) (b)

Figure 3: (a) Dielectric constant and (b) loss factor of samples RA82, RA64, and RA46.

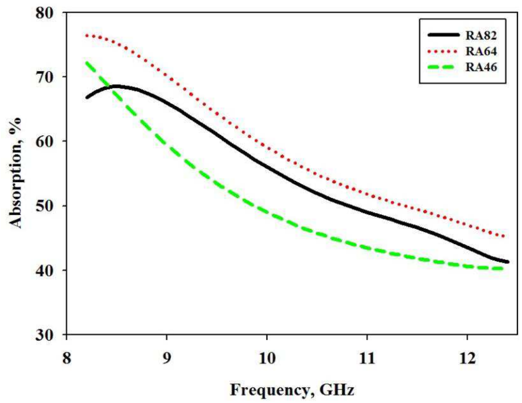


Figure 4: Percentage microwave absorption of RH-RHA samples.

increase from 3.6 to 4.7 and 0.43 to 0.79. The different ratio of RH-RHA samples has various values of dielectric properties.

4.2. Microwave Absorption

The RH-RHA samples was simulate in CST microwave studio to obtain the reflection loss (S_{11}). Then microwave absorption was calculated using Equation (1). Figure 4 shows the microwave absorption of RH-RHA samples.

The microwave absorption of RH-RHA samples were decreased with increasing the frequency. The RA82 sample microwave absorption 40–70% over 8.2–12.4 GHz frequency region. The microwave absorption of RA64 and RA46 are 40–73% and 46–76% respectively. The RA64 has the highest microwave absorption compare to RA82 and RA46. The highest absorption point of RA64 sample at 8.2 GHz with 76% microwave absorption. The average microwave absorption values of RA82, RA64, and RA46 are 54.92%, 58.74%, and 50.15% respectively over frequency region.

5. CONCLUSIONS

The various ratio RH-RHA composites have the different dielectric properties. The dielectric properties of RH-RHA samples were increased with the RHA amount increased in the composites ratio. The microwave absorption of RH-RHA samples with 5 mm thickness was decreasing with increasing the frequency. The RA64 microwave absorber has the best microwave absorption in 8.2–12.4 GHz frequency range.

ACKNOWLEDGMENT

The authors acknowledge the University Malaysia Perlis and the Malaysian Ministry of Higher Education for providing the Fundamental Research Grant Scheme (FRGS Grant No.: 9011-00011), which enabled the publication of this article.

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