Radar Absorbing Materials Double Layer From Laterite Iron Rocks And Actived Carbon Of Cassava Peel In X-Band Frequency Range

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Abstract— In recent years, laterite iron sand-actived carbon composites based on natural ingredient were successfully introduced as microwave absorbers material. In this research work, laterite iron sand-active carbon composites has been made from laterite iron rock, Tanah Laut, South Kalimantan to be laterit iron sand and active carbon will be achieve by activation method with KOH from cassava peel. This laterite iron sand-active carbon composites coating is applied to steel grade A type AH36. Microwave absorbing properties were investigated by measuring reflection loss in the 8.2-12.4 GHz microwave frequency range using network analyser. The results of microwave absorbing properties studies showed that the reflection loss of laterite iron sand-actived carbon composites is higher than uncoated steel samples.

Keywords— cassava, actived carbon, iron sand, laterite, absorbers

INTRODUCTION

Electromagnetic absorption material has become a hot topic research topic because of usage in both military and civil applications: radar, space technology, telecommunication, local area networks, personal digital assistant, etc [1,2]. High conductivity, dielectric permitivity, and magnetic permeability of the material contribute to high electromagnetic interference (EMI) shielding efficiency [3]. Pure dielectric or magnetic materials insufficiently absorb radiation energy [4]. Theoritically, the mixture of both of them can absorb electromagnetic wave with specific frequencies.

On the other hand, carbon due to low density, exquisite mechanical and excellent EM shielding properties, have been widely used as reinforcements and even EM interference suppressors [5,6]. As a kind of typical candidates, carbon materials receive intensive attention due to their tunable properties, relative low density, abundant resource, easy preparation, and low cost. Up to now, a series of carbon materials with different forms, such as carbon nanotubes (CNT), carbon nanofibers (CNF), carbon nanocoils, carbon foams, graphene, active carbon, etc., have been utilized as main components of novel microwave absorbers. Beside that, laterite from iron sand have a good performance as microwave absorber, which is have magnetic properties.

Based on these backgrounds, laterite coating on actived carbon is a potential way to enhance the EM shielding properties of active carbon. In this studi, laterite and active carbon double layer will be synthesized. The microwave absorption properties of these samples were then evaluated.

EKSPERIMENTAL

a. Synthesizing Actived Carbon

Carbon used as the dielectric material. Carbon was extracted from cassava peel. The extraction process taken about eight day. First the cassava peel was separated from the meat, and the peel was washed until clean. Second, the peel was cut with 50x50 mm size, then the peel dried inside oven by temperature 50^{o}C for two until three days. After that, The dried cassava peel was drying at temperature 130^{o}C for 16 Hours. Then, the cassava peel allowed during one day. Then, the peel was placed with temperature 300^{o}C for two hours. Fourth, the cassava peel was mashed by ceramic mortar, then sifted by strainer 100 mesh. Fifth, 5 grams sifted carbon was activated by 20 ml KOH 3 M, then was stirred for one hour. Sixth, activated carbon was precipitated for 48 hours. After that, the precipitated was neutralized by HCL until the PH was 6-7. Then, it was dried on oven with temperature 50^{o}C for 24 hours.

b. Laterite Purification

Laterite was extracted from iron rocks. The rocks was crashed into iron sands. After that, the sands filtered by strainer 100 mesh. The filtered sands become soft powder of sand. Then the magentic material or Ferrite (Fe_3O_4) which contained in soft powder was separated by strong magnet until the laterite looks clean. After that, taken a little from the powder to be sample of XRD test. Then, the cleaned Ferrite was cleaned in ultrasonic cleaner and mixed with alcohol 96% about five times by changing the alcohol. After that, the alcohol was removed and Fe_3O_4 allowed to be dried at room temperature. Then the half dried Fe_3O_4 put down in the artificial oven -made from lamp inside a box to be full dried about one until two days. Then, taken a little from the powder to be sample of XRD test.

c. Actived Carbon and Laterite Mixing

Active carbon and laterite mixed with ratio 1:1. Both were mixed with alcohol 96% in ultrasonic cleaner about 30 minutes. Then, the alcohol was removed, and the mixture allowed at room temperature. The half dried mixture placed into the artificial oven. After that, the dried mixture was heated in furnace with 300°C about two hours. Then, the mixture was chilled with room temperature.

d. Double Layer Coating on Ship Steel Plate

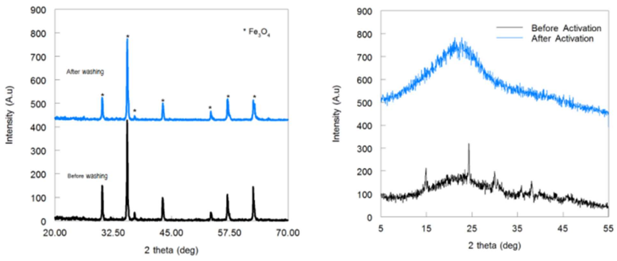
Agatha ship paint stirred with the samples by mechanical mixing with ratio $m_{mixture} : m_{paint} = 1 : 9$. Variation of the samples to be coated on plates are: a) Laterite + active carbon (L+C), b) LC+L, c) LC + C, d) C+L, e) active carbon (C) and e) laterite (L). Samples stirring done during ten minutes until the mixture was being homogeneous by mixer with rapidity 8000 rpm. After the stirring process is done, the material was being layered (4mm) smoothly on steel plate grade A type AH36. Material coating was being dried during several days.

For the coating metal samples, the coupons were polished by emery papers, washed with distilled water. This laterite and active carbon coating on the surface as double layer of steel grade A type AH36. The measurement of reflection loss versus frequency of the composite coating were tested by vector network analyzer in the range 8-12 GHz.

RESULT AND DISCUSSION

a. Crystalline Structure Analysis

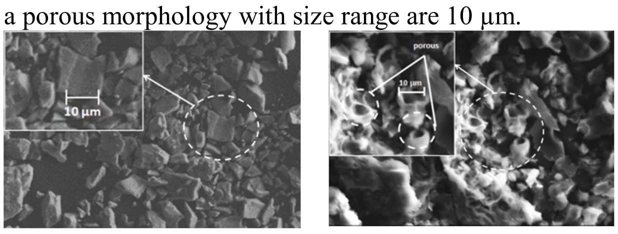
In Fig.1 the X-ray powder diffraction (XRD) patterns laterrite before and after washing, and carbon after and before and after activation have been shown, respectively. The XRD pattern measured from the laterrite showed that crystalline laterrite was exist and indicated that the powders had high purity in this value. According to the results, there existed phases of Fe_3O_4, including magnetite showing good agreement with PDF 96-900-5839. Three diffraction peaks at 2θ angles of 30º, 35º, 45º etc seemed to be the characteristic peaks for structure of Fe_3O_4 phase. Beside that active carbon after and before have amorphous background but have the same peak at at 2θ angles of 23º, indicating the amorphous nature of these carbon materials.



(a) (b)

Fig. 1. XRD pattern of the (a) Laterrite and (b) Actived Carbon

Fig. 2 shows the Scanning Electron Microscopy (SEM) image of laterite and active carbon. It can be seen that laterite (Fig.1.a) exhibits aggregated particles with cubic morphology, but the size is not homogen. The SEM of active carbon (Fig.1.b) indicates that active carbon have a porous morphology with size range are 10 µm.



(a) (b)

Fig. 2. SEM images (a) laterrite and (b) active carbon

The FTIR spectra of the active carbon and active carbon : laterite (1:1) are shown in Fig. 3. As shown in Fig. 3, the strong absorption bands that appear at 443 cm^{-1} and 570 cm^{-1} (Fe–O bonding) are the characteristic band of laterite. There are characteristic broad bands of actived carbon located at 2923 cm^{-1} and 1272 cm^{-1} in the IR spectrum. Based on the result of FTIR and XRD identification that no new phase appear in the sample. Pure active carbon occur at 3398 cm^{-1} (O-H bending), 2923 cm^{-1} dan 2869 cm^{-1} (C-H bending), 1689 cm^{-1} (C=O bending), and 763 cm^{-1} (=C-H bending).

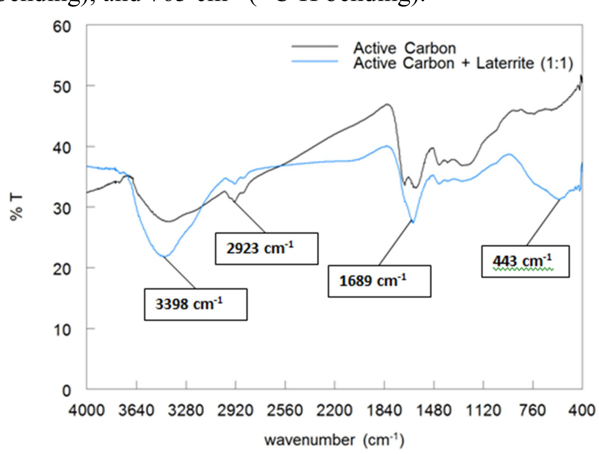


Fig. 3. FTIR spectra of active carbon and active carbon + laterrite (1:1)

b. Magnetic Properties

The magnetic properties of the pure laterite measured by Vibrating Sample Magnetometer (VSM), as shown Fig. 4. The magnetic parameters such as saturation magnetization (Ms), coercivity (Hc), and remnant magnetization (Mr) have been given in Table 1. It can be clearly seen that the value of saturation magnetization pure laterrite is so high 120 emu/gr. The magnetic measurements of laterite have low coercivity (0.05 T) and low remanance values (19.8 emu/g) in the ‘as synthesized’ condition. This confirms the formation of soft magnetic phase (laterite) in the ‘as synthesized’ condition which is also confirmed by XRD pattern (Fig. 1(a)) of ‘as synthesized’ powder, because laterite iron sand included low ferromagnetic.

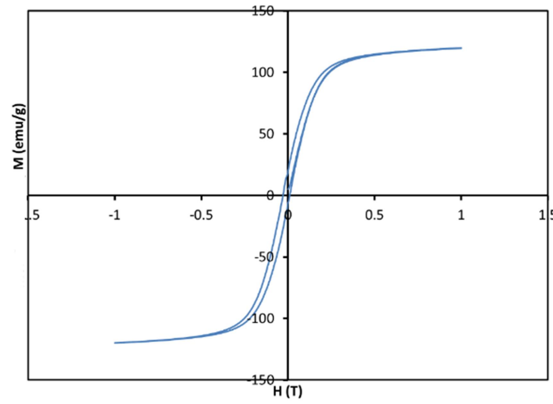


Fig. 4. Hysteresis loop at room temperature of pure laterrite

Table 1. Magnetic property of pure laterite

Sample	Ms (Emu/gr)	Hc (T)	Mr (Emu/gr)
Laterrite	120	0.05	19.8

c. The Electrical Conductivity

The effect of the laterite content on the electrical conductivity of the sample showed in Fig. 5. The electrical conductivity of active carbon and laterite depends on the amount of carbon in the sample. In other words, electrical conductivity of the laterite can be enhanced by the conductive active carbon adding. Active carbon makes the conducting particles slightly larger, showed that active carbon and laterite have conductivity in range 10^{-8} S/cm. Beside that, the value of conductivity cassava peel as active carbon is in the range 10^{-8} S/cm. The values of conductivity indicated that the actived carbon is in the range of dielectric materials.

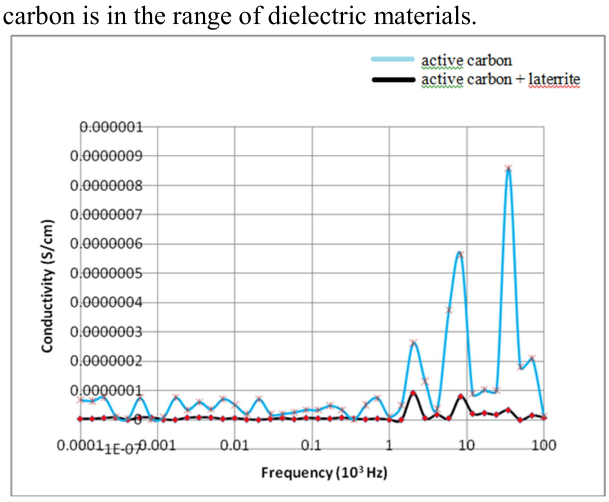


Fig. 5. Conductivity of active carbon as a function of frequency

d. Microwave Absorption Properties

The calculated reflection losses of laterite and active carbon as a function of frequency for all samples are shown in Fig. 6. As shown in Fig. 6, the minimum RL value at the X-band (8.2-12.4 GHz) achieves -15.5 dB at 8.8 GHz and the maximum reflection loss at the radar band (8-12 GHz) are -19.4 dB at 8 GHz. Based on the analysis, order preparation sample give an effect on the microwave absorption properties.

The result also showed that (Fig.6) the positions of microwave absorption peaks moved towards the higher frequencies by change composition of active carbon and laterite as double layer. This indicates that the absorption peak frequency of the active carbon and laterite can be manipulated easily by changing the compilation of active carbon and laterite. Generally excellent electromagnetic wave absorption is resulted from the efficient complement between the relative permittivity and the permeability of materials [7]. Either only the magnetic loss or only the dielectric loss may induce a weak electromagnetic wave absorption property due to the imbalance of the electromagnetic match. For the pure active carbon, only dielectric loss (complex permitivity) contributed to the electromagnetic loss, while for laterite, the effect of magnetic loss was dominant over the dielectric loss. It means that the magnetic loss and the dielectric loss were out of balance in both the cases, which resulted in less electromagnetic wave absorption. The improved microwave absorption of the active carbon and laterite with mixed paint obviously originated from the combination of the diamagnetic active carbon and low ferromagnetic laterite, which had better match of the dielectric loss and magnetic loss. The -15.5 dB absorption bandwidth corresponds to 85% EM wave amplitude attenuation.

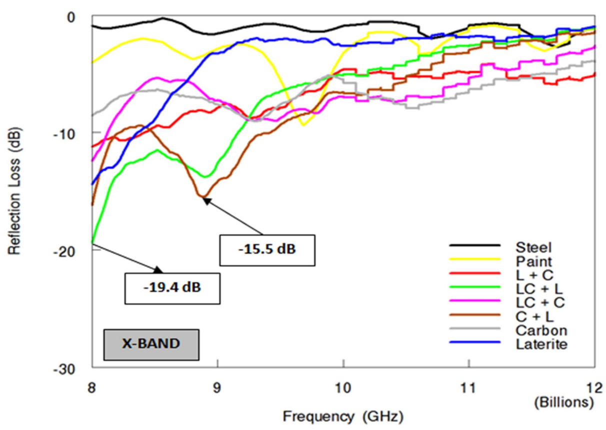


Fig. 6. Microwave reflection losses of the samples at 8-12 GHz

CONCLUSION

The laterrite and actived carbon composites exhibiting electromagnetic properties were succesfully extraction method from iron sand with cubic morphology and actived carbon with high purity level will be achieved by activation method with KOH as porous material. The composites use laterrite and active carbon weight ratios 1:1 with thickness 4 mm. The conductivity of the active carbon measured by the two-point probe conductivity were at range 10^{-8} S/cm. The magnetic hysteresis loops of materials investigated with Vibrating Sample Magnetometer (VSM) indicated that the saturated magnetization (Ms) of pure laterrite was up to 120 emu/gr.

This laterrite and active carbon with double layer coating applied to a steel grade A type AH36. Microwave absorbing properties were investigated by measuring reflection loss in the 8-12 GHz microwave frequency range using network analyser. The results of microwave absorbing properties studies showed that the reflection loss of laterite and active carbon is higher than uncoated steel samples. The maximum reflection loss of of laterite and active carbon was about -15.5 dB at 8.8 GHz. The results confirmed that laterite and active carbon influenced of microwave absorber composites. Due to the reflectivity performance and easy and low cost preparation routes, the active carbon and laterite has a promising potential for microwave absorber.

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