CONFERENCE PROCEEDING

Electromagnetic Wave Absorbing Performance of Activated Carbon Based Agricultural Waste - A Review

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ABSTRACT

In this new era of technology, many new devices involving electronic devices especially in the tele-communication are being developed in order to fulfil human needs and provide their daily facilities. These devices are being designed to function at higher frequency (gigahertz) range. The high frequency electromagnetic wave device is drawing more attention in manufacturing and upgrading the development of the economy, military and medical industry. However, these daily technological devices produce electromagnetic interference that can adversely affect our health. The rapid increase in electromagnetic interference also received serious attention from researchers in producing more electromagnetic absorbing materials especially suited at high gigahertz frequencies. Hence, using activated carbon from agricultural waste can be the best solution to this problem due to its high carbon content and cheap availability. Agricultural wastes are inexpensive and renewable additional sources for activated carbon, thus being a bonus for this method of settlement and it can increase economic returns as well. Each material has its own value and properties of electromagnetic wave absorbing strength. In this review paper, the differences between agricultural waste materials used as electromagnetic wave absorbers have been presented. This includes the properties of the activated carbon produced from the different agricultural waste materials, the method of preparation, and the result obtained from the activated carbon as an electromagnetic wave absorbing material. This review paper also highlights the materials' characteristics, advantages and results of the introduction of honeycomb structure as a composite that will be used as an electromagnetic wave absorbing material. Moreover, the differences of materials' properties in agricultural waste materials as activated carbon affects the percentages of electromagnetic waves that can be absorbed was also highlighted.

Keywords: *Electromagnetic absorbing materials, agricultural waste, honeycomb structure*

INTRODUCTION

Technology nowadays is evolving over time, as many devices that produce electromagnetic waves at high frequencies are increased that can adversely affect and disrupt civilian communication, military systems and human health. For years, researchers have been focusing on developing light weight, low cost, thin thickness, flexible, eco-friendly and effective absorber with strong reflection loss (Yusuf *et al*, 2021). Activated carbon are expensive and limited use for large-scale applications to act as the electromagnetic wave absorber. Therefore, activated carbon based agricultural waste bears huge potential to be applied as an alternative and beneficial invention for various applications.

Production of activated carbon from agricultural waste has potential for economic and environmental advantages where agriculture is the main economic activity for all countries. This is because it converts unwanted, low-value agricultural waste to useful high-value adsorbents (Mdoe *et al*., 2014). It also provides an excellent method for the agricultural solid waste management thereby reducing the environmental pollution. The activated carbon from agricultural waste can be use as

electromagnetic absorbing material due to its high potential of absorbing properties and others beneficial factor (Mdoe *et al*., 2014).

This review attempts to evaluate the performance of activated carbon from different types of agricultural waste. Other factor such as the method used to produce the activated carbon also plays a role in this situation. Also, this review will summarize the best and most commonly used of all out the methods. Finally, this review concentrates on the evaluation of performance outcome from each different type of activated carbon-based agricultural waste.

MATERIALS AND METHODS

Materials

Different types of agricultural waste with higher lignin and cellulose content results in greater potential of activated carbon used as electromagnetic wave absorbers. The percentages of each agricultural waste contents have been summarized in Table 1.

Table 1. Agricultural materials contents

Materials	Cellulose (%)	Hemicellulose (%)	Lignin (%)	References
Rice husk	38	18	22	Patmawati *et al*., 2020
Wood sawdust	40	10	30	Muley *et al*., 2019
Sugarcane bagasse	42.16	36	19.3	Chen *et al*., 2012
Terminalia catappa	37.9	21.6	40.3	Ouensanga *et al*., 2003
Coconut shell	26.6	17.74	41.18	Sangian *et al*., 2018
Walnut shell	40.1	20.7	18.2	Gonzalez *et al*., 2009

The cellulose and hemicellulose content have the potential to be activated carbon using carbonation and activation processes. Other than that, these materials also contained high carbon element which helps to absorb the microwave signal, which is focal in ensuring satisfactory reflectivity of the microwave absorber, aside from being light in nature.

Preparation of activated carbon

There are many ways in the production of activated carbon such as through carbonization process. Based on the reviewed journals, it can be concluded that there are two steps need to be taken in producing the activated carbon. The first step is carbonization step and second is activation step. First, the material is cleared from foreign materials, soil and gravel and further crush into a size of 0.5 to 1 cm and dry at temperature of 100ºC (24 hours). The material further undergo carbonization process and the activation process is conducted using any suitable activation agent by soaking it at room temperature for 24 or 48 hours. The materials are washed with distilled water until it reached pH~7. It is then filtered and dried at temperature of 100℃-110 ℃ to obtain an activated carbon. After the preparation of activated carbon from agricultural waste, the activated carbon will further mix with resin or bonding agent and produce polymer composite material.

RESULTS AND DISCUSSION

The absorption coefficient increases with the thickness of the sample. The microwave absorption properties are improved with the addition of activated carbon. The investigation showed that different material and resin mix will give different dielectric constant and reflectivity of electromagnetic absorber.

Table 2. Summary of the performance of different types material

Materials	Activating agent	Matrix	Thickness	Frequency (GHz)	Reflection loss (dB)	Ref
Rice husk	1 M of HCl	-	6.0mm	7.8	-11.2	Zulpadrianto *et al.*, 2018
	1M of KOH	-	6.0mm	7.8	-6.0	
	-	20% of Phenol Formaldehyde (PF)	2.0cm	8.0	-85.947	Nornikman *et al.*, 2009
	-	10% of Urea Formaldehyde (UF)	2.0cm	12.0	-71.597	
Wood sawdust	ZnCl2	polyurethane	2.4cm	1.9	-10.4	Shaaban *et al.*, 2015
Sugarcane bagasse	-	Polyester resin + methyl ethyl ketone peroxide (hardener)	2.0cm	15.0	-70.0	Liyana *et al.*, 2012
Coconut shell	1 M of HCl	-		10.52	-8.42	Kurniawan *et al.*, 2021
Walnut shell	KOH	-	2.0mm	8.8	-42.4	Yusuf *et al.*, 2021

CONCLUSION

In this review, the activated carbon derived from agricultural waste materials has been presented. These results indicate that the activated carbon derived from agricultural waste also has great potential to serve as filler to be used as electromagnetic wave absorbing materials. Various carbon materials such as coal, lignite, bark, wood, and peat are used in the production of commercial activated carbon. A potential method to reduce its cost is to produce activated carbon from low-cost materials such as agricultural by-products that are relatively inexpensive, obtainable and effectively used in replacing activated carbon from the current carbon materials.

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