Solid State Science and Technology, Vol. 18, No 1 (2010) 238-243
ISSN 0128-7389

MONITORING OF RUBBERWOOD TREATMENT BY MICROWAVE DIELECTRIC PROPERTIES

Nor Aina Abd Wahab[1] , Kaida Khalid[1], Hamami Sahri[2], Zaidon Ashaari[2] and Mohd Nasir Mat Arip[3]

[1] *Physics Department, Faculty of Science, University Putra Malaysia, 43400, Serdang, Selangor*

[2] *Faculty of Forestry, University Putra Malaysia, 43400, Serdang, Selangor*

[3] *Forestry Research Institute Malaysia (FRIM), 52109 Kepong, Selangor Darul Ehsan*

ABSTRACT

Nowadays wood is widely used in most country. Therefore, preservation of wood is very important to make sure that the wood can be used for a long time and do not decay due to some factors such as pest, insect, weather or other factors. Several methods are used to determine the effectiveness of wood preservation. Usually, the methods used in laboratory test are malt-agar culture tests, soil block test, and agar-block test. The other methods are permanence and accelerated exposure such as leaching test, weathering test, and stakes test. All these test are time consuming and expensive, because more chemical analyses involved, and none has been accepted as a standard for general use. In this study, we are monitoring the wood treatment by using microwave dielectric loss technique at frequency ranging from 0.2 to 3 GHz. The water borne preservatives used in this treatment were Borax, Alkaline Copper Quaternary (ACQ), and Chromate Copper Arsenic (CCA). Naturally, the dielectric properties of rubberwood are very small and the ionic conductivity can be negligible. After treated with chemicals preservatives which are having high ionic conductivity, the dielectric properties of treated wood are increased and become ionic. The dielectric loss and mass of the sample reduce in same pattern with time as water evaporated from the wood.

INTRODUCTION

Microwave techniques were uses widely in wood industry in this time. The most uses of microwave applications were drying, heating and gluing wood. For wood product, the dielectric properties have already studied on large scale such as to investigate the dielectric properties of wood, moist wood, wood based materials. All these studied were influenced by anisotropy, density, frequency, temperature and field direction relative to wood structure.

Preservation of wood is important to make sure the wood can be used for a long time and not decay because of pest, insect, weather or another else. Several methods were used to determine effectiveness of wood preservation. The methods usually use in laboratory test are malt-agar culture tests, soil-block test, and agar-block test. All of these tests are time consuming and expensive, because of the most number of chemical analyses involved, and none has been accepted as a standard for general use. Other methods are permanence and accelerated exposure test such as leaching test, weathering test, and stakes test. This method need long time to observe.

This paper will discuss the monitoring of rubberwood treatment by microwaves technique.

MATERIALS AND METHODS

The size of the rubber wood used for this treatment is 2 cm x 2 cm x 2cm in three structural directions; longitudinal, radial and tangential. Before the treatment process, the mass, density and dielectric properties of every wood sample were measured. The mass of sample was measured using the electronic balance and the density of wood was measured by Toledo Balance.

The chemical substances used in the treatment were Chromated Copper Arsenic (CCA), Alkaline Copper Quaternary (ACQ) and Borax. The entire chemical has its own function but all of them are water borne preservative. Water borne preservatives leave the wood surface comparatively clean, paintable and free from objectionable odor.

One of the successful methods of preservative treatment of wood is pressure impregnation of the wood. Firstly, the samples were placed in the cylinder and a preliminary vacuum applied for ½ hour. This process is to remove the air and water from the wood cell. While the vacuum is maintained, preservative solution was filled the cylinder and wood totally immersed. A pressure was applied to force solution into wood until wood starts refusal. When process was finished, the pressure was released slowly to atmospheric conditions. Normally the pressure apply in this process is about 1MPa.

After the treatment process the dielectric properties and mass of treated wood are measured for every 2hour until saturated value is achieved. The dielectric properties were done by using open-ended coaxial sensor and Network Analyzer [1].

RESULTS AND DISCUSSION

Figure 1 shows the dielectric constant and dielectric loss of rubberwood with moisture content about 20% before the treatment process. The value of dielectric loss very small since these was small contribution from ionic conductivity.

Solid State Science and Technology, Vol. 18, No 1 (2010) 238-243
ISSN 0128-7389

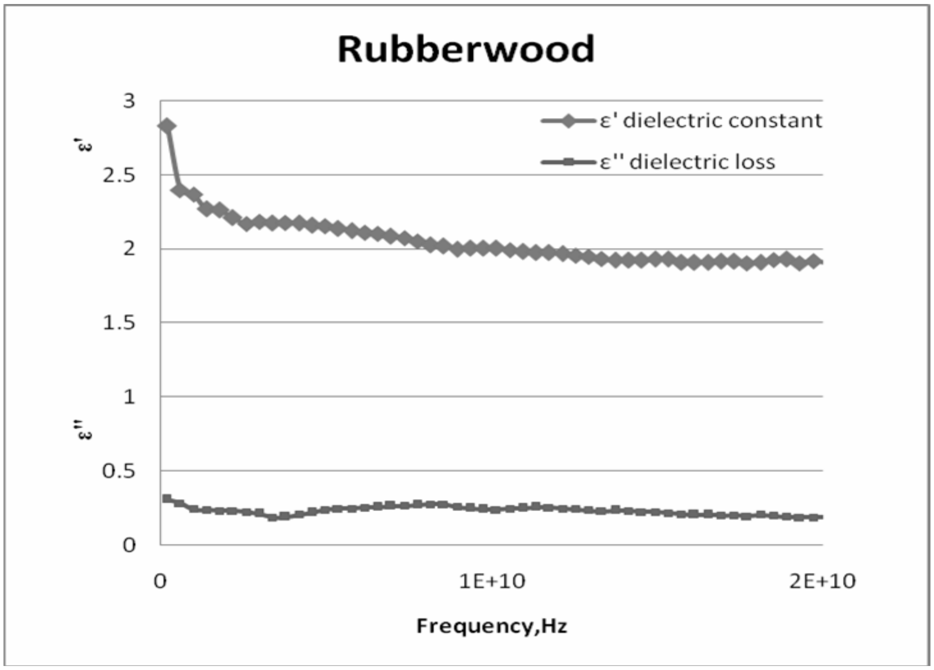

Figure 1 : Dielectric properties of Rubberwood.

The dielectric properties of chemical preservative was shown in Figure 2 . As shown in Figure 2, the dielectric loss of these chemical is very high is due to ionic conductivity. CCA solution gives the highest dielectric loss as compare to Borax and ACQ solutions.

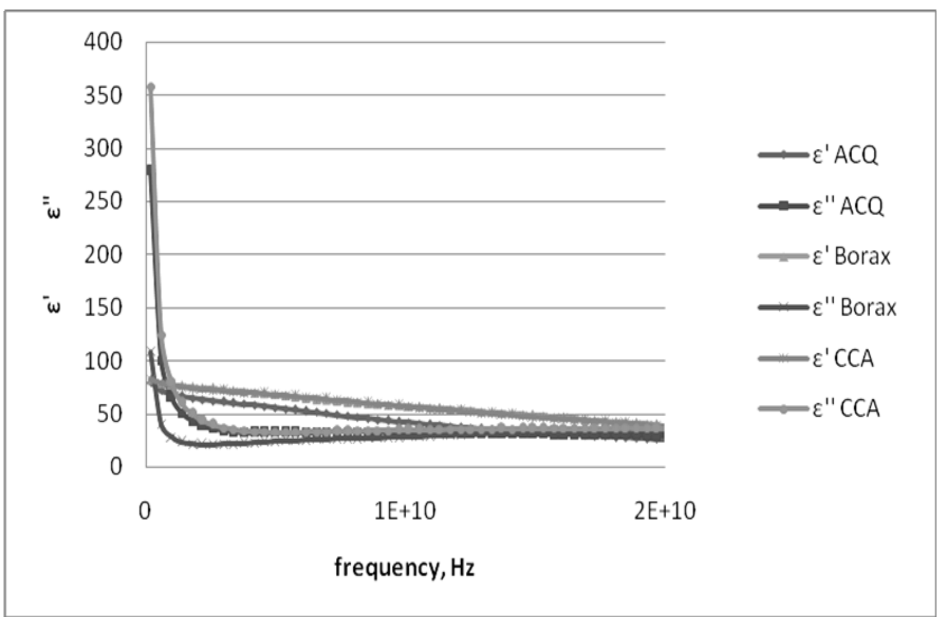

Figure 2 : Dielectric properties of Chemical Preservation.

Figure 3 shows the dielectric loss of rubberwood after treatment for three different chemical preservatives. The similar pattern of the decrement of the dielectric loss can be seen for each sample which is quite similar to the decrement of mass of the sample. The drop of dielectric loss is quite drastic for the first 2 hours and slowly decreasing to saturated value as water slowly evaporates from the sample. By using ACQ treatment, the time to stabilize was about 48 hours. It is clearly show that the detection of treated chemical depends on the present of water in the sample.

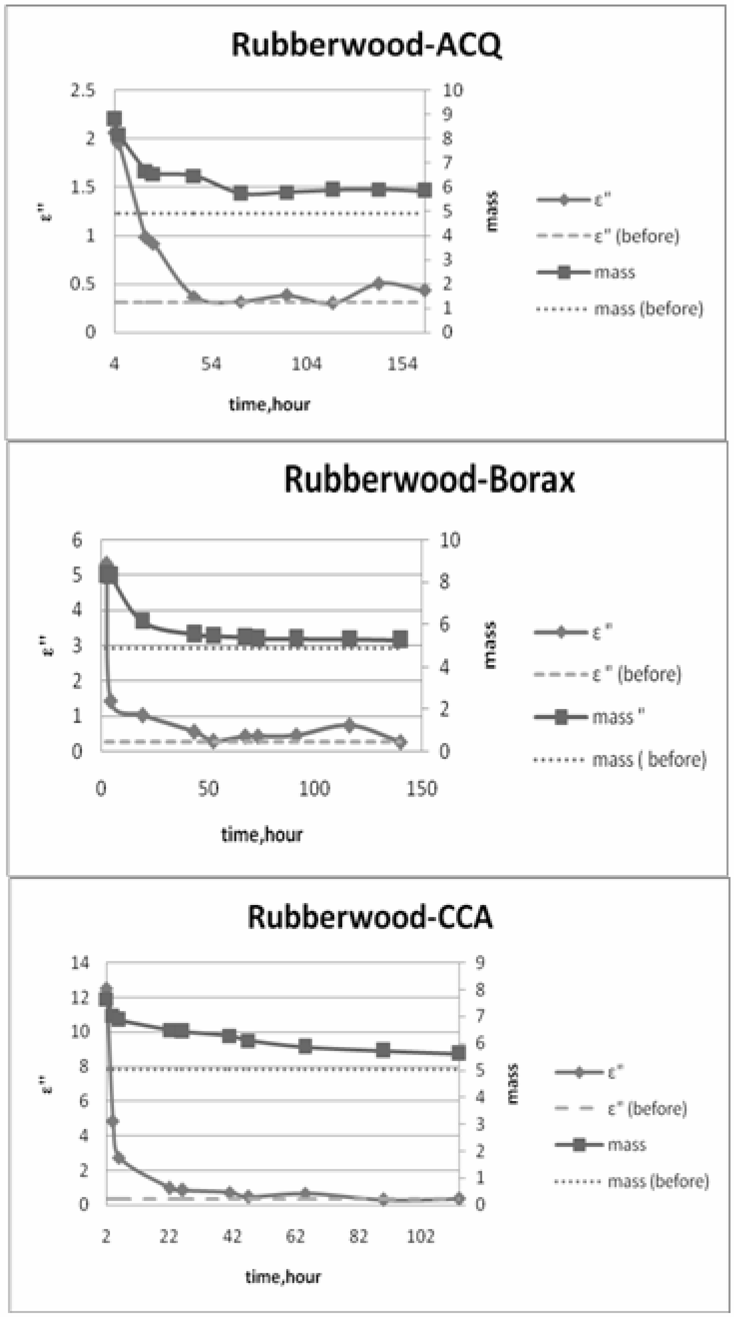

Figure 3: Dielectric loss of Rubberwood after treatment.

Solid State Science and Technology, Vol. 18, No 1 (2010) 238-243
ISSN 0128-7389

In this study, the relationship between structural direction and dielectric loss areas shown in Figure 4. The orientations of the wood direction were corresponding the direction of electric field of the microwaves interact with sample. The results show the dielectric constant, ε' and dielectric loss, ε" of rubberwood in longitudinal direction is higher than tangential and radial direction. The difference in dielectric properties for all directions is depend on the differences in the arrangement of the wall and lumen, the specific molecular structure of the cell wall and the anisotropy of the cell wall substances. The highest values for ε' and ε" are obtained because the electric field parallel to the wood fiber.

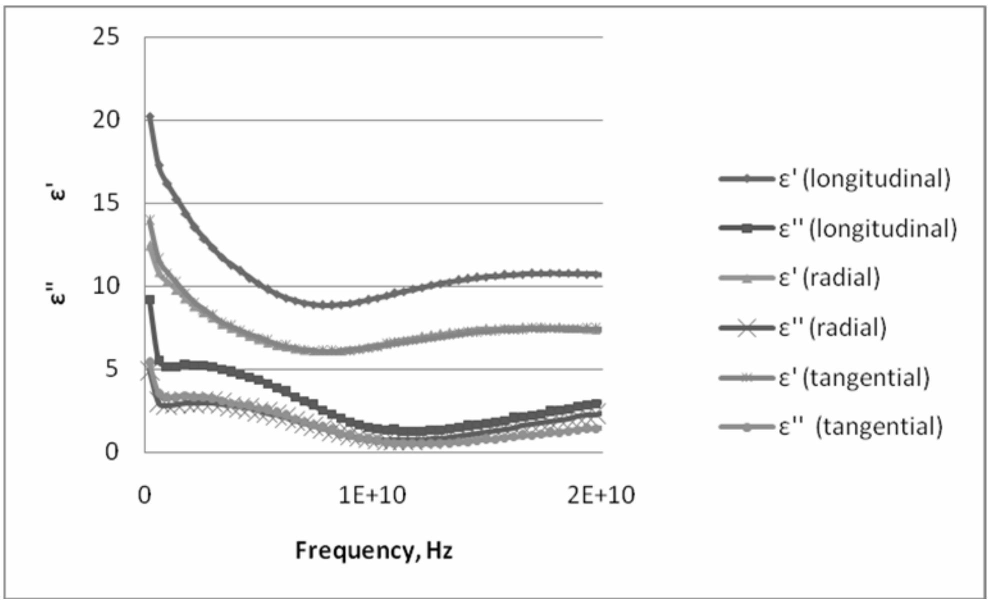

Figure 4: Dielectric properties of rubberwood in various directions after treatment.

CONCLUSION

Microwave method can be used to monitor the completeness of wood treatment process by measuring dielectric loss of the samples. Decrement dielectric loss with time after treatment is almost corresponding to the decrement mass of the samples. In this study also, we have found the detection of dielectric loss in longitudinal direction is much higher than tangential and radial. Finally, from this study there is a possibility to use microwave technique to detect the presence of the chemical in aged treated wood.

ACKNOWLEDGEMENTS

The author would like to thank Ministry of Higher Education for the Fundamental Research Grant Scheme (5523133) and UPM for the Graduate Research Fellowship (GRF). Also thanks to Forestry Research Institute Malaysia (FRIM) for the advice and technical support.

Solid State Science and Technology, Vol. 18, No 1 (2010) 238-243
ISSN 0128-7389

REFERENCES

[1] Kabir MF, Khalid KB, Daud WM, Aziz SHA (1997) Dielectric properties of rubber wood at microwave frequencies measured with an open-ended coaxial line. Wood Fiber Sci **29**, 319–324

[2] E. Peyskens, M. de Pourcq, M. Stevens and J. Schalck(1984) Dielectric properties of softwood species at microwave frequencies. Wood Sci. Technol. **18**, 267-280

[3] Hamiyet Sahin · Nurgül Ay (2004) Dielectric properties of hardwood species at microwave frequencies. Wood Sci. Technol. **50**, 375–380

[4] Barry A Richardson (1978). Wood preservation. Lancaster New York: The Construction Press

[5] Daian G, Taube A, Birnboim A, Shramkov Y, Daian M (2005) Measuring the dielectric properties of wood at microwave frequencies. Wood Sci Technol **39**(3), 215–223

[6] Torgovnikov GI (1993) Dielectric properties of wood and wood-based materials. Springer, Berlin Heidelberg New York

[7] Norimoto M (1976) Dielectric properties of wood. Wood Res **59-60**, 106–152