Advanced Materials Research Vol. 896 (2014) pp 440-443
Online available since 2014/Feb/19 at www.scientific.net
© (2014) Trans Tech Publications, Switzerland
doi:10.4028/www.scientific.net/AMR.896.440

Microwave properties of composite $Ba_{0.5}Sr_{0.5}Fe_{11.7}Mn_{0.15}Ti_{0.15}O_{19}/La_{0.7}Ba_{0.3}MnO_3$ material

Viktor Vekky Ronald Repi[1,2,a],Azwar Manaf[1,b], Bambang Soegiono[1]

[1]Postgraduate Program of Materials Science,Jalan Salemba Raya 4, Jakarta 10430,

Department of Physics, Universitas Indonesia, Indonesia

[2]Department of Physics Engineering, Universitas Nasional, Jakarta, Indonesia

[a]vekky_repi@yahoo.com(corresponding author)[b]azwar@ui.ac.id

Keywords: Microwave properties, composite material, magnetic and electric material, absorber material, mechanical alloying.

Abstract. Mn-Ti substituted Barium - Strontium Hexaferrite and Barium – Lanthanum Manganite both well established materials which have been shown poses microwave absorbtion properties. As the properties of composite system are a composition sensitive, composite materials must be properly designed to meet a specific application. In this paper, we report our recent investigation on microwave absorbtion properties of composite $Ba_{0.5}Sr_{0.5}Fe_{11.7}Mn_{0.15}Ti_{0.15}O_{19}/La_{0.7}Ba_{0.3}MnO_3$ system. Composite components respectively $Ba_{0.5}Sr_{0.5}Fe_{11.7}Mn_{0.15}Ti_{0.15}O_{19}$ and $La_{0.7}Ba_{0.3}MnO_3$ were prepared through mechanical alloying route employing a planetary ball mill for 20 hrs. The two milled powders were sintered at a temperature 1100 ^{0}C for 10 hours to ensure the crystallization towards fully crystalline materials. Composites with 2 different compositions were studied by FTIR and VNA from which results were compared with that of each component. Results of the investigation concluded that, the composite of $Ba_{0.5}Sr_{0.5}Fe_{11.7}Mn_{0.15}Ti_{0.15}O_{19}/La_{0.7}Ba_{0.3}MnO_3$ system is a good microwave absorbing material in the frequency range 9 GHz-15 GHz, particularly, sample with coded A03B07 has a wide range frequencies absorption.

INTRODUCTION

Recently, most telecommunication systems and wireless networks are operated at radio frequencies (RF) and microwavefrequencies. By the increasingly usage width band frequencies for communication and information technology, we are facing electromagnetic pollution and electromagnetic interference. Absorption of electromagnetic wave (EMW) occurs in magnetic materials due to the magnetic loss. Ferrites exhibit substantial magnetic loss in the vicinity of their ferromagnetic resonance (FMR). So they are one of the best materials for microwave absorbers. Absorbers material can be produced as ceramics material or as composites material. The EMW properties of material composites can be very effectively tuned, simply by varying the volume fractions of the constituent material phases.[1, 2]. In this paper we present the influence of composition material on microwave behavior in composite systems $Ba_{0.5}Sr_{0.5}Fe_{17}Mn_{0.15}Ti_{0.15}O_{19}$ / $La_{0.7}Ba_{0.3}MnO_3$ to find material composition that has width absorption regime.

MATERIAL AND METHOD

$B_{0.5}Sr_{0.5}Fe_{11.7}Mn_{0.15}Ti_{0.15}O_{19}$ (A) and $La_{0.7}Ba_{0.3}MnO_3$ (B) were prepared by using conventional ceramic method. The sample was synthesized from stoichiometric mixture of $BaCO_3$, $SrCO_3$, $MnCO_3$, TiO_2 $Fe_2O_3$for (A) and La_2O_3, $BaCO_3$, $MnCO_3$for (B) respectively.The mixture sample (A) and (B) weredry milling for 20h and sintered in air at 1100^{o}C for 10h. Finally both samples (A) and (B) were crushed to make a composite with weight ratio variation and pressed in the form of disc with the diameter of 25 mm and the thickness of 20 mm. The composite specimens were prepared by mixing the (A) and (B) sample in different weight ratio x = 0, 0.3, 0.7, 1. In order to analyze the phase of prepared composite powder, X-ray diffraction (XRD) analysis was performed with Co-Kα radiation and the difraction patern was recorded from 20^o to 100^o. The sample was also characterized by means of fourier transform infrared (FT-IR) spectroscopy. FT-IR measurements were carried out by using Shimadzu. The microwave properties for absorbing material trace from parameter scattering by means vector network analyzer from Advantest.

RESULTS AND DISCUSSION

Fig. 1 shows the XRD patterns of the A10B00, A07B03, A03B07, A00B10 composite. The difraction peaks shown in A10B00 can be well indexed to the hexagonal structure $BaFe_{12}O_{19}$ (barium hexaferrite)on data base of COD (Crystallography Open Database) with the entry data number 96-100-8322. It has hexagonal crystal structure with space group Pb63/mmc (194) and lattice constants a = 5.9290Å. c = 23.4130Å. For A00B10 comfirms of $LaMnO_3$ phase with orthorombic structure, space group Pbnm(62) and lattice parameter are a=5.5520 Å, b = 5.7269 Å and c = 7.7365 Å. XRD patterns for all samples with chemical formula based on weight fraction of (A)/(B) are presented in table 1.

Table 1: Sumarry of composite used in this study

Notation in this paper	Chemical formula (1-*x*)A / *x*B
A10B00	$Ba_{0.5}Sr_{0.5}Fe_{11.7}Mn_{0.15}Ti_{0.15}O_{19}$
A07B03	$(0.7)Ba_{0.5}Sr_{0.5}Fe_{11.7}Mn_{0.15}Ti_{0.15}O_{19}$ / $(0.3)La_{0.7}Ba_{0.3}MnO_3$
A03B07	$(0.3)Ba_{0.5}Sr_{0.5}Fe_{11.7}Mn_{0.15}Ti_{0.15}O_{19}$ / $(0.7)La_{0.7}Ba_{0.3}MnO_3$
A00B10	$La_{0.7}Ba_{0.3}MnO_3$

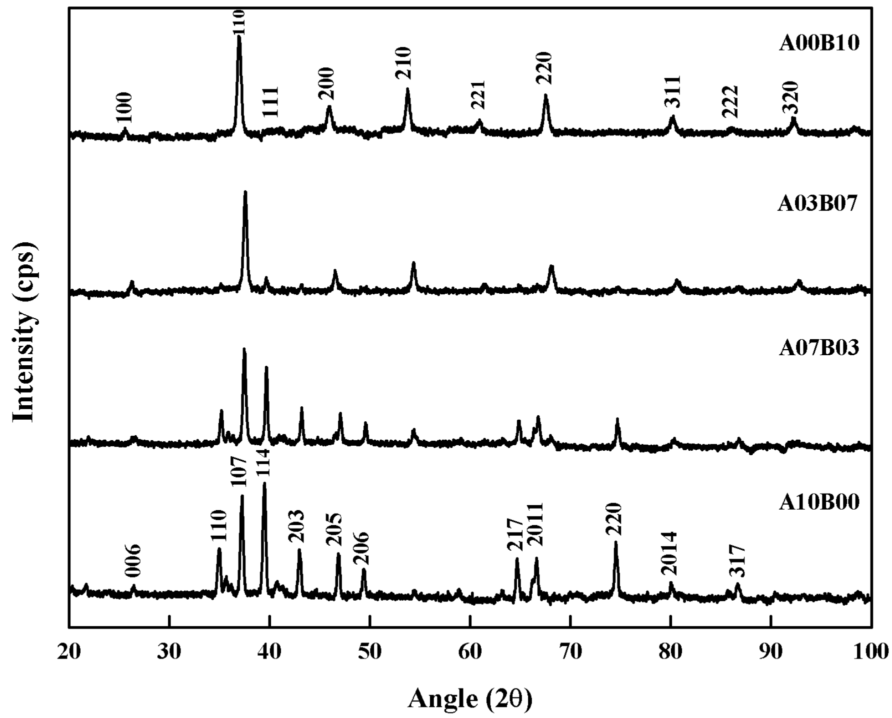

Fig. 1. XRD patern of composite $B_{0.5}Sr_{0.5}Fe_{11.7}Mn_{0.15}Ti_{0.15}O_{19}$ (A) and $La_{0.7}Ba_{0.3}MnO_3$ (B)

For further characterization, the FT-IR spectrum was recorded in the range of 4000-400 cm^{-1}. The IR spectra for four samples A10B00, A07B03, A03B07 and A00B10 are shown in Fig. 2. In the range 1000-100cm^{-1}, the infrared bands of solid are usually assigned to the vibration and stretching of ion in the crystal lattice. There are two bands near 700cm^{-1} and 400cm^{-1} indicated the presence of cation-anion interaction in the octahedral for 629.77, 626.88, 621.09$cm^{-1}$and tetrahedral for 447.49, 440.74cm^{-1} site, respectively. The absorption band observed within this limit reveals the formation of the spinel structure [5, 6].

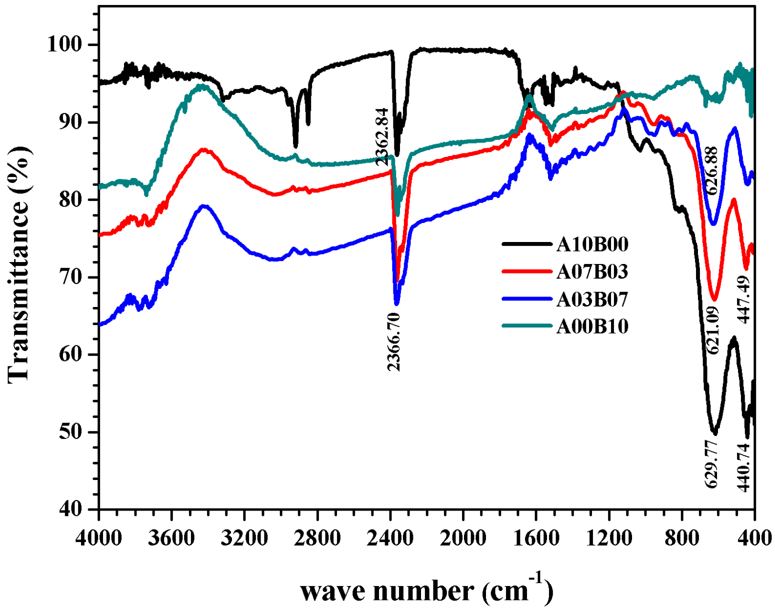

Fig. 2. Infrared spectrum for A10B00, A07B03, A03B07 and A00B10 composite.

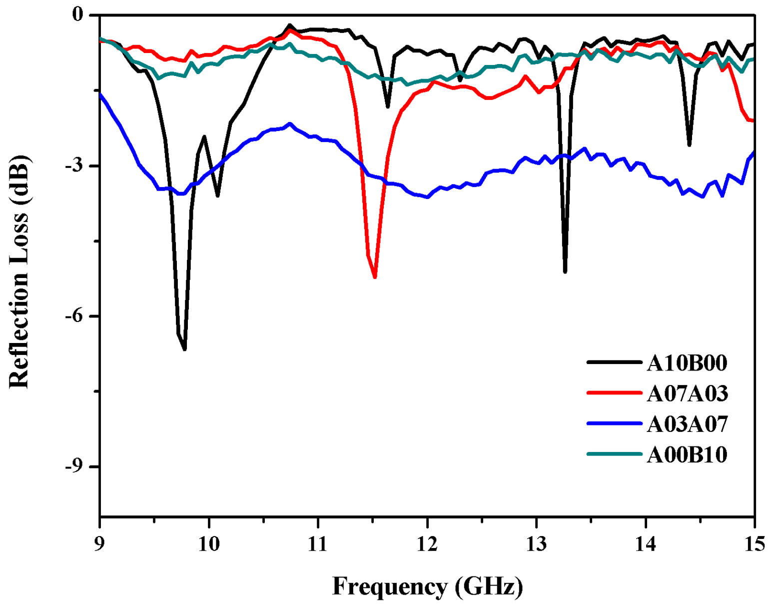

Fig.3. Frequency dependences of reflection loss (*RL*) for the four samples: A10B00, A07B03, A0307 and A00B10.

According to the transmission line theory, the reflection loss (*RL*) of electromagnetic radiation under normal incident wave at surface of single layer material was backed by metal. The *RL* is related to the normalized imput impedanceZ_{in} as :

$$RL = 20\log|(Z_{in} - 1)/(Z_{in} + 1)| \qquad (1)$$

$$Z_{in} = \sqrt{}(\mu_r/\varepsilon_r)\ \tanh[j\, 2\pi/c\ \sqrt{}(\mu_r \varepsilon_r)\, fd] \qquad (2)$$

where *f* is the frequency of the electromagnetic wave, *d* is the thickness of an absorber, *c,* is the velocity of light. According to equations (1) and (2), the measurement of the reflection loss of the composites with a thickness of 2.5 mm is shown in Fig. 3. Sample A10B00 has two extreme peaks, 9.5-10GHz and 13-13.5 GHz that have *RL* -7.1 dB and -5.4 dB, respectively. Sample A07B03 has one peak at 11.5 GHz and the *RL*at -5.5 dB. Sample A03B07 has wide range absorption frequency but the depth is less than -4 dB. Sample A00B10 has a minimum *RL*, it is less than -1.5 dB for wide range frequencies. The variation peaks for all samples at lower frequency is due to the domain wall motion. Several peaks at higher frequencies are due to the spin resonance, respectively. According to the analysis above, it has been determined that the electromagnetic absorption of the composite (A)/(B) sample is mainly ascribed to the combination of dielectric loss, which is associated with intrinsically dielectric properties and structure of the samples, as well as the magnetic loss which is attributed to nature resonance and strong interface coupling interaction between magnetic phase and electrical phase [7].

CONCLUSION

In this paper, we have prepared types of composites using a conventional ceramic method for electromagnetic wave absorbing in microwave regime. We find out that sample A03B07 has wide range frequencies absorption even though absorption maximum depth less than -6 dB. Sample A10B00 has more than one peaks absorption but has maximum absorption depth -7.1 dB. As a conclusion, all composites exhibit good candidat for electromagnetic absorbing in the frequency range 9-15 GHz

ACKNOWLEGMENT

The present work are supported by Direktorat Pendidikan Tinggi under research grant no. 2026/H2.R12.3/PPM.00 Penelitian and research grant no. 014/K3.KU/2012 from which the authors are very grateful.

REFERENCES

[1] M. Vopsaroiu, M. Cain, G. Sreenivasulu, G. Srinivasan dan A. Balbashov, “Multiferroic composite for combined detection of static and alternating magnetic fields,” Materials Letters, no. 66, pp. 282-284, 2012.

[2] S. T. a, H. B. Baskey, R. C. Agarwala dan V. Agarwala, “Development of hard/soft ferrite nanocomposite for enhanced microwave absorption,” Ceramics International, no. 37, pp. 2631-2641, 2011.

[3] M. Molaei, A. Ataie, S. Raygan, S. Picken, E. Mendes dan F. Tichelaar, “Synthesis and characterization of BaFe12O19/Fe3O4 and BaFe12O19/Fe/Fe3O4 magnetic nano-composites,” Powder Technology, no. 221, pp. 292-296, 2012.

[4] S. V. Trukhanov, “Magnetic and magnetotransport properties of La12-xBaxMnO3x/2 perovskite manganites,” Journal of Materials Chemistry, no. 13, p. 347–352, 2003.

[5] I. Sharifi dan H.Shokrollahi, “Structural, Magneticand Mossbauer evaluation of Mn substituted Co–Zn ferrite nanoparticles synthesized by co-precipitation,” Journal of Magnetism and Magnetic Materials, no. 334, pp. 36-40, 2013.

[6] R. Bhowmik dan a. N. Naresh, “Structure, ac conductivity and complex impedance study of Co3O4 and Fe3O4 mixed spinel ferrites,” International Journal of Engineering, Science and Technology, vol. 2, no. 8, pp. 40-52, 2010.

[7] W. Chen, J. Zheng dan Y. Li, “Synthesis and electromagnetic characteristics of BaFe12O19/ZnO composite material,” Journal of Alloys and Compounds, no. 513, pp. 420-424, 2012.

Advanced Materials Science and Technology

10.4028/www.scientific.net/AMR.896

Microwave Properties of Composite $Ba_{0.5}Sr_{0.5}Fe_{11.7}Mn_{0.15}Ti_{0.15}O_{19}/La_{0.7}Ba_{0.3}MnO_3$ Material

10.4028/www.scientific.net/AMR.896.440