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Microwave Absorber Properties $\text{La}_{0.67}\text{Sr}_{0.33}\text{Mn}_{0.8}\text{Ni}_{0.2}\text{O}_3$ Using Sol Gel Synthesis Methods

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Abstract

This paper reports the process and the results are supplemented by material microwave absorber characterisation $\text{La}_{0.67}\text{Sr}_{0.33}\text{Mn}_{0.8}\text{Ni}_{0.2}\text{O}_3$ which has been synthesised by sol gel method. Results refinement of the XRD data showed that the material $\text{La}_{0.67}\text{Sr}_{0.33}\text{Mn}_{0.8}\text{Ni}_{0.2}\text{O}_3$ have formed a single phase. From the results of using the software refinement High Score obtained crystal size on sample of 21.18 nm. Number of spin concentration in the sample at ESR test results showed a decrease when doping Ni increased, the area under the curve of absorption decreases as 388.718. This is due to the substitution of Ni^{2+} ions Mn^{3+} ions thus inhibiting electron hopping of electrons e_g (Mn^{3+} ion) to t_{2g} (Mn^{4+} ion) in the mechanism of double exchange so that the spin of the electrons will t_{2g} antiparallel. Competition between ferromagnetic properties with antiferromagnetic spin make will change the direction so that the sample magnetisation will decrease and the magnetic moments become random. ESR results are used to confirm the results of the VNA. Microwave absorption ability is indicated by the value of reflection loss on the sample is -66.67 dB.

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Keywords: microwave absorber, $\text{La}_{0.67}\text{Sr}_{0.33}\text{Mn}_{0.8}\text{Ni}_{0.2}\text{O}_3$, sol gel, double exchange

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Introduction

The microwaves in the range of 1 – 20 GHz is currently being increasingly used in public for example on the radar, wireless telecommunication systems, local area networks (LANs), and various other telecommunications equipment [1]. On the one hand, these developments make it easier to live a modern society, but on the other hand can cause various social problems such as increased electromagnetic interference (EMI) and electromagnetic susceptibility (EMS), therefore the material needed to absorb the microwave [2]. As absorber of microwaves, the material required is material to the

value of high permeability and permittivity and combinations there of in impedance so that the resulting material with strong absorption. In this case, the magnetic metal nano-particles allows it to be used as the EM-wave absorber due to high relative permeability at a frequency radar waves [3]. The last few years particularly in the transition metal doped LaMnO_3 as magnetic metal with the effect of colossal magneto-resistance (CMR) showed high application potential in the field of electronic magnetic material. In addition, the electromagnetic characteristics of the oxide material make it a good absorber of microwaves [1]. Interest for the researchers to $\text{La}_{1-x}\text{T}_x\text{MnO}_3$ ($T = \text{Sr, Ca, Ba}$) due

to the characteristics of electromagnetism especially colossal magnetoresistance effect that has been reported [3]. Doped Ni with a certain ratio is expected to improve the magnetic properties.

Experimental Details

$\text{La}_{0.67}\text{Sr}_{0.33}\text{Mn}_{0.8}\text{Ni}_{0.2}\text{O}_3$ is made by sol gel method with a combination of precursor materials $\text{La}(\text{NO}_3)_3$, $\text{Sr}(\text{NO}_3)_2$, $\text{Mn}(\text{NO}_3)_2 \cdot 4\text{H}_2\text{O}$, and $\text{Ni}(\text{NO}_3)_2 \cdot 6\text{H}_2\text{O}$ with scales on each material according to stoichiometric [4]. All the precursor material aquabidest nitrate dissolved, then the solution is mixed and stirred using a magnetic bar with a constant speed 300 rpm and the constant temperature at 800°C . Then we adjust pH around 7 with added ammonia solution around 15 ml. When the solution has been stirred for 3 hours, viscous solution will turn into a paste. If the water content is reduced and the magnetic rod can not rotate anymore, so put the sample in the oven for 2 hours at temperature 120°C to decrease the water content. And then calcined at a temperature of 550° for 8 hours to remove the element of nitrate and citrate, the sample will be issued black fluffy. Samples black-gray and then crushed using a mortar until it forms a perfect powder, after which the samples through a sintering stage at a temperature of 850° for 5 hours. Then our sample compacted with a pressure of 2 tons for three minutes so that the sample into a solid form. then the sintered sample with a temperature of 1200 degrees celsius for two hours. Finally sample bulk is characterised by XRD, ESR and VNA.

Results and Discussion

This sample has been synthesised by sol gel route, then characterised by X-Ray Diffraction (XRD), Electron Spin Resonance (ESR) and Vector Network Analyzer (VNA) to see about microwave absorbance properties.

Figure 1 showed that the sample with code of $x = 0.20$ has a single phase with rhombohedral crystal structure. Refinement result of samples $\text{La}_{0.67}\text{Sr}_{0.33}\text{Mn}_{0.8}\text{Ni}_{0.2}\text{O}_3$ show that this sample is single phase with crystallite structure rhombohedral in space group R-3c, and crystallite size about 21.18 nm.

Number of spin concentration in the sample at ESR test results showed a decrease, sample $x = 0.00$ has area under curve 8645.54 and sample $x = 0.20$ has area under curve 388.718 (as shown in Figure 2). So when doping Ni plus, the area under the curve of absorption decreases. This is due to the substitution of Ni^{2+} ions Mn^{3+} ions thus inhibiting electron hopping of electrons e_g (ion Mn^{3+}) to t_{2g}

(Mn^{4+} ion) in the mechanism of double exchange so that the spin of the electrons will t_{2g} antiparallel.

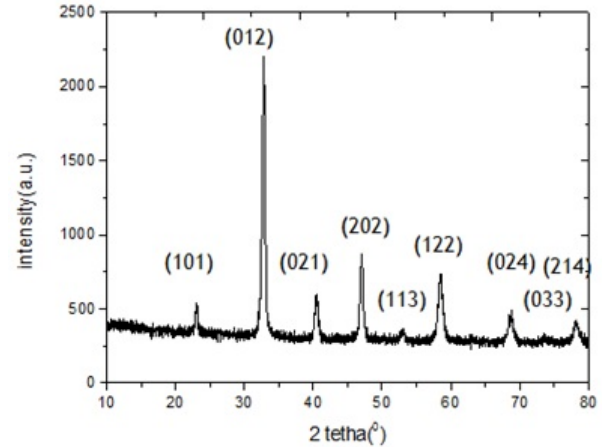


Figure 1: XRD pattern of $\text{La}_{0.67}\text{Sr}_{0.33}\text{Mn}_{1-x}\text{Ni}_x\text{O}_3$ with $x = 0.20$.

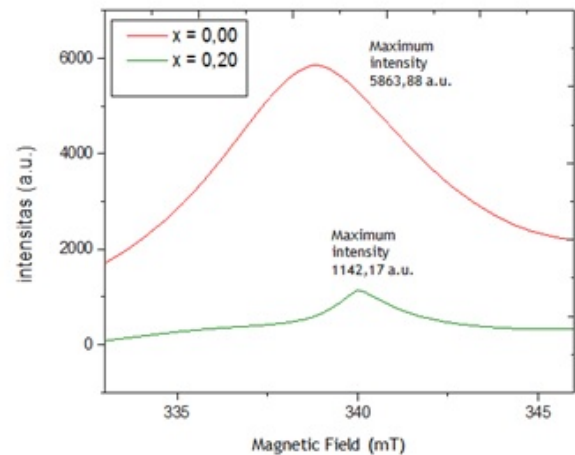


Figure 2: ESR pattern of $\text{La}_{0.67}\text{Sr}_{0.33}\text{Mn}_{1-x}\text{Ni}_x\text{O}_3$ with $x = 0.00$ and $x = 0.20$.

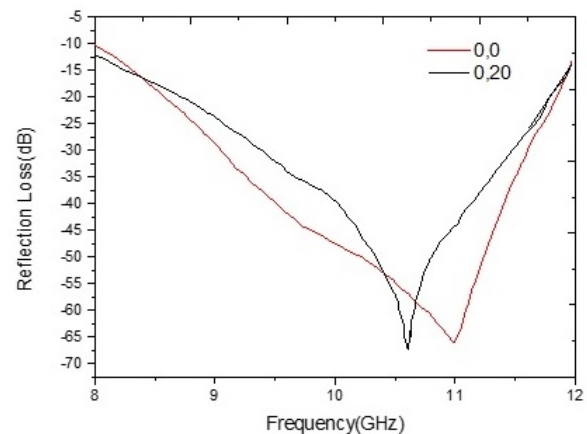


Figure 3: VNA result of $\text{La}_{0.67}\text{Sr}_{0.33}\text{Mn}_{1-x}\text{Ni}_x\text{O}_3$ with $x = 0.00$ and $x = 0.20$.

Competition between ferromagnetic properties with antiferromagnetic spin make will change the direction so that the sample magnetisation will decrease and the magnetic moments become random.

Figure 3 showed that the samples with $x = 0.20$ reflection loss increased compared to the sample with $x = 0.00$. Value of reflection loss of -66.67 dB for sample $x = 0.20$ and sample $x = 0.00$ at -65.37 dB. ESR results are used to confirm the results of the VNA.

Conclusion

Sample $\text{La}_{0.67}\text{Sr}_{0.33}\text{Mn}_{0.8}\text{Ni}_{0.2}\text{O}_3$ has been made with sol gel method with the results of refinement in the form of single-phase samples with rhombohedral crystal structure. Number of spin concentration in the sample at ESR test results showed a decrease, when doping Ni plus, the area under the curve of absorption decreases. This is due to the substitution of Ni^{2+} ions Mn^{3+} ions thus inhibiting electron hopping of electrons e_g (ion Mn^{3+}) to t_{2g} (Mn^{4+} ion) in the mechanism of double exchange so that the spin of the electrons will t_{2g} antiparallel. Competition between ferromagnetic properties with antiferromagnetic spin make will change the direction so that the sample magnetisation will decrease and the magnetic moments become random. ESR results are used to confirm the results of the

VNA. Microwave absorption ability is indicated by the value of reflection loss on the sample is -66.67 dB.

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