Pengaruh substitusi ION Fe-Ti terhadap ION Mn pada sistem La1-xSrxMnO3 sebagai material penyerap gelombang mikro frekuensi 9-15 GHz = The influence of Fe-Ti ions substitution to MN in the La1-xSrxMnO3 as microwave absorbing materials in the frequency range 9-15 GHz

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Abstrak

Telah dilakukan karakterisasi parameter kristal, sifat kemagnetan dan serapan gelombang mikro pada material berbasis lanthanum-strontium manganite komposisi La1-xSrxMnO3 (x=0-1) serta efek subsitusi parsial ion Fe dan Ti pada material komposisi La0.7Sr0.3Mn1-yFey/2Tiy/2O3 (y = 0-1). Preparasi material dilaksanakan melalui metode pemaduan mekanik diikuti dengan sintering pada temperatur 1100C selama 2 jam.
Hasil pengujian dengan XRD terhadap material pasca perlakuan sintering memastikan material terdiri dari fasa kristalin. Diketahui bahwa ion Sr tidak dapat mensubsitusi ion La sepenuhnya pada senyawa komposisi La1-xSrxMnO3 dengan batas kelarutan x = 0.3 tanpa terjadi perubahan sistem kristal dan fasa tunggal. Substitusi ion Fe terhadap ion Mn pada senyawa komposisi La0.7Sr0.3Mn1-yFeyO3 (y=0-1) tidak menyebabkan perubahan struktur kristal yaiu tetap berstruktur monoklinik dikarenakan jari-jari ion Fe3+(6.4 nm) dan Mn4+ (5.4 nm) tidak jauh berbeda. Namun, tidak demikian dengan efek subsitusi parsial ion Ti4+ pada komposisi La0.7Sr0.3Mn1-yTiyO3 (y=0-0.8) ditandai dengan perubahan struktur kristal monoklinik pada y = 0 menjadi orthorombik pada komposisi 0<y0.8 dan pada y > 0.5 material memiliki fasa kedua yang mengindikasikan terdapatnya batas maksimum fraksi ion Ti4+ (jari-jari 6.05 nm) menggantikan ion Mn4+. Efek subsitusi parsial ion Fe, Ti serta subsitusi bersama ion Fe dan Ti terhadap ion Mn menyebabkan perubahan struktur magnetik dari keteraturan ferromagnetik menjadi paramagnetik melalui suatu mekanisme interaksi pertukaran spin elektron. Perubahan sifat kemagnetan material ini diketahui dari loop hysteresis magnet melalui evaluasi menggunakan perangkat permeameter. Senyawa material berbasis lanthanum strontium manganite berbagai komposisi yang menjadi objek penelitian ini semua memiliki kemampuan menyerap gelombang elektromagnetik paling tidak pada jangkauan frekuensi 9–15 GHz yang diketahui berdasarkan analisis hasil pengujian dengan vector network analysis atau VNA. Hasil evaluasi menunjukkan material fasa tunggal komposisi La0.7Sr0.3Fe0.2Mn0.4Ti0.4O3 dengan ketebalan 2.05 mm dan bersifat paramagnetik memiliki nilai return loss maksimum sebesar -9.13 dB atau mampu menyerap gelombang mikro sebesar 65.05% pada frekuensi 10.9 GHz dan lebar frekuensi penyerapan optimum sebesar 4 GHz.
......Crystal parameter as well as magnetic properties and microwave absorption characteristics of material based on lanthanum-strontium manganese with La1- xSrxMnO3 (x = 0-1) compositions have been characterized. These are including the effects of partial substitution of Fe ions in La0.7Sr0.3Mn1-yFey/2Tiy/2O3 (y=0-1) series. Material preparation was carried out through mechanical alloying method followed by sintering at a temperature of 1100 0C for 2 hours. Identification study of x-rays traces for sintered materials ensured that all materials consisted of crystalline phases.
It is shown that Sr ion can completely substitutes La ion in the La1-xSrxMnO3 (x = 0.3) compositions with no change in the crystal system and remains as single phase materials. Similarly, there was also no crystal

structure changing observed when Fe ion substituted the Mn ion in the $La_{0.7}Sr_{0.3}Mn_{1-y}Fe_yO_3$ (y=0-1) compositions. Apparently, the crystal structure was maintained due to almost similar size of ionic radii between Fe^{3+} (6.4 nm) and Mn^{4+} (5.4 nm). However, a different case occurred in Ti substituted $La_{0.7}Sr_{0.3}Mn_{1-y}Ti_yO_3$ (y=0-0.8) in which the crystal structure of monoclinic for y = 0 changed to orthorhombic for $0 < y 0.8$. In addition, the second phase was found in materials with $y > 0.5$ which indicated that there must be a maximum ionic fraction limit of Ti^{4+} in replacing Mn^{4+} due to larger ionic radii (6.05 nm) than that of Mn^{4+}.

It was also found that substitution of respectively Fe and Ti ions in $La_{0.7}Sr_{0.3}Mn_{1-y}(Fe,Ti)_yO_3$ (y=0-1) series as well as co-substitution of Fe and Ti ions for Mn in $La_{0.7}Sr_{0.3}Mn_{1y}Fe_{y/2}Ti_{y/2}O_3$ series have lead to the magnetic structure changing from ferromagnetic order to paramagnetic through a mechanism of electron spin exchange interactions. The change in magnetic structure was seen from the hysteresis loop obtained by means of permeameter measurement. The lanthanum-strontium manganese-based materials of various compositions which were the objects of this study have shown the ability to absorb electromagnetic waves at least in the frequency range of 9-15 GHz. This was confirmed by results of analysis based on vector network analyzer (VNA). It is concluded that a paramagnetic single-phase material of $La_{0.7}Sr_{0.3}Fe_{0.2}Mn_{0.4}Ti_{0.4}O_3$ composition with 2.05 mm thickness has a maximum return loss value of 9.13 dB, which capable to absorb 65.05% of incident microwaves intensity at a frequency 10.9 GHz with the absorption width was 4 GHz.