Pengembangan bahan magnetik sistem La(1-y)BayFexMn½(1-x)Ti½(1-x)O3 (x = 0 ? 1,0 and y = 0 ? 1,0) sebagai bahan penyerap gelombang elektromagnetik = Development of magnetic material La(1-y)BayFexMn½(1-x)Ti½(1-x)O3 (x = 0 ? 1.0 and y = 0 ? 1.0) system as for electro-magnetic wave absorber

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Abstrak

Beberapa dekade terakhir ini peredam gelombang elektromagnetik (microwave absorber) dari bahan magnetik telah banyak digunakan untuk aplikasi di bidang pertahanan militer, elektronik dan telekomunikasi. Secara sederhana dapat dikatakan bahwa bahan absorber gelombang elektromagnetik adalah sebuah bahan yang dapat melemahkan energi gelombang elektromagnetik. Bahan-bahan yang memiliki kriteria sebagai bahan absorber gelombang elektromagnetik adalah bahan harus memiliki karakteristik permeabilitas (magnetic loss properties) dan permitivitas (dielectric loss properties). Kandidat potensial sebagai bahan absorber gelombang elektromagnetik adalah bahan magnetik sistem ABO3 perovskite lanthanum manganite. Dengan rekayasa struktur sistem lanthanum manganite ini diharapkan dapat menjadi bahan unggul untuk aplikasi microwave absorber. Pengembangan bahan magnetik yang dilakukan dalam penelitian ini mencakup sistem La(1-y)BayFexMn½(1-x)Ti½(1-x)O3 (x = 0 - 1,0 dan y = 0 - 1,0) telah diperoleh komposisi yang paling baik yaitu komposisi senyawa La0.8Ba0.2Fe0.3Mn0.35Ti0.35O3. Sintesis nanopartikel senyawa La0.8Ba0.2Fe0.3Mn0.35Ti0.35O3 fase tunggal telah berhasil diperoleh melalui metode pemaduan mekanik dilanjutkan dengan tahapan sintering pada suhu 1000 °C selama 10 jam. Sintered materials kemudian dihaluskan kembali selama 20 jam. Hasil refinement pola difraksi sinar-x menunjukkan bahwa senyawa La0.8Ba0.2Fe0.3Mn0.35Ti0.35O3 memiliki struktur monoklinik dengan parameter kisi a = 5,5182(8) Å, b = 5,5442(8) Å, c = 7,822(1) Å, dan  = 89,63(1)o. Ukuran rata-rata kristalit partikel senyawa La0.8Ba0.2Fe0.3Mn0.35Ti0.35O3 adalah 42 nm. Sedangkan ukuran rata-rata partikelnya berdasarkan pengujian dengan Particle Size Analyser adalah 72 nm. Material bersifat ferromagnetik memiliki karakteristik nilai permeabilitas dan permitivitas yang baik. Hasil pengujian serapan gelombang elektromagnetik pada rentang frekuensi 9 - 15 GHz menunjukkan bahwa terdapat tiga frekuensi puncak serapan pada frekuensi 9,9 GHz, 12,0 GHz, dan 14,1 GHz dengan nilai reflection loss berturut-turut sebesar ~ 9 dB, ~ 13 dB, dan ~ 25 dB. Disimpulkan bahwa bahan sistem La(1-y)BayFexMn½(1-x)Ti½(1-x)O3 (dengan x = 0 - 1,0 dan y = 0 - 1,0) menjadi kandidat yang potensial untuk digunakan sebagai bahan unggul absorber gelombang elektromagnetik.
<hr>Recently electromagnetic wave absorber materials haves been used for military, electronic, and telecommunication devices. In a very simple definition, electromagnetic wave absorber material is a material that can weaken the electromagnetic wave energy. Basic properties which are required of electromagnetic wave absorber materials were that the materials must have high permeability (magnetic loss properties) and high permittivity (dielectric loss properties) values. One of potential candidates for absorbing materials is ABO3 perovskite lanthanum manganite-based system. Structurals modification of the basic lanthanum manganite was applied in order to find the best the microwave absorber characteristics of the modified materials system. Current research activities were covering La(1-y)BayFexMn½(1-x)Ti½(1-

x)O3 (x = 0 - 1.0 and y = 0 - 1.0) compositions. It was found that the best composition with an improve microwave absorption characteristic is La0.8Ba0.2Fe0.3Mn0.35Ti0.35O3. Single phase of La0.8Ba0.2Fe0.3Mn0.35Ti0.35O3 nanoparticles were successfully synthesized by mechanical alloying method. The mixture of all precursors were first mechanically milled for 10 hrs and then sintered at a temperature of 1000 °C for 10 hrs in which a fully crystalline material is ensured. The sintered material was then re-milled for 20 hrs to obtain powder-based nanoparticles. The refinement of x-ray diffraction trace for re-milled materials confirmed a single phase material with a monoclinic structure of lattice parameters: a = 5.5182(8) Å, b = 5.5442(8) Å, c = 7.822(1) Å, and  = 89.63(1)o. The mechanically alloyed and sintered materials in the whole mechanical milling resulted in powders with mean crystallite size 42 nm. The mean particle size as refering to the particle size analyzer was 72 nm in the second mechanically milled powders. Thus, results of mean crystallite size and crystallite size evaluations for the powder materials showed that the mean crystallite zise is almost similar to the mean particle size. In addition, the hysteresis curve evaluation showed that the sample material is ferromagnetic. Results of VNA evaluation indicated that there were three of absorption peaks with reflection loss values ~ -9.0 dB, ~ -11.5 dB, and ~ -25.0 dB at frequency 9.9 GHz, 12.0 GHz, and 14.1 GHz respectively. The study concluded that the magnetic materials of La(1-y)BayFexMn½(1-x)Ti½(1-x)O3 compositions (x = 0 - 1,0 and y = 0 - 1) have a good potential to be a candidate of electromagnetc wave absorbing materials.