

Karakteristik serapan gelombang mikro material campuran nanopartikel $\text{BaO}_6(\text{Fe}_{1.7}\text{Mn}_{0.15}\text{Ti}_{0.15}\text{O}_3)$ dan $\text{La}_{0.8}\text{Ba}_{0.2}\text{MnO}_3$ melalui proses pemaduan mekanik dan ultrasonik daya tinggi = Microwave absorption characteristic of $\text{BaO}_6(\text{Fe}_{1.7}\text{Mn}_{0.15}\text{Ti}_{0.15}\text{O}_3)$ dan $\text{La}_{0.8}\text{Ba}_{0.2}\text{MnO}_3$ combined nanoparticle materials by mechanical alloying and high powered ultrasonic

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Abstrak

Dalam karya tulis ini disampaikan hasil kegiatan penelitian tentang sintesis material penyerap gelombang mikro yang terdiri dari campuran partikel senyawa $\text{BaO}_6(\text{Fe}_{1.7}\text{Mn}_{0.15}\text{Ti}_{0.15}\text{O}_3)$ dan $\text{La}_{0.8}\text{Ba}_{0.2}\text{MnO}_3$ berukuran nanometer hasil sintesis melalui teknik pemaduan mekanik dan destruksi ultrasonik. Kedua jenis material hasil sintesis adalah material berfasa tunggal dipastikan dari hasil identifikasi pola difraksi sinar X. Hasil evaluasi pengukuran distribusi ukuran partikel dengan Particle Size Analyzer (PSA) menunjukkan bahwa ukuran rata-rata partikel senyawa $\text{La}_{0.8}\text{Ba}_{0.2}\text{MnO}_3$ dan $\text{BaO}_6(\text{Fe}_{1.7}\text{Mn}_{0.15}\text{Ti}_{0.15}\text{O}_3)$ pasca tahapan sintesis melalui teknik pemaduan mekanik masing-masing adalah 733 nm dan 714 nm. Keduanya memiliki distribusi normal dengan jangkauan ukuran relatif lebar ~ 600 nm. Jangkauan ukuran partikel pada fungsi distribusi ukuran bagi kedua jenis material sama-sama menyempit disertai dengan mengecilnya ukuran rata-rata partikel yaitu masing-masing menjadi 354 nm, 168 nm dan 70 nm pasca destruksi ultrasonik 1, 3 dan 5 jam bagi senyawa $\text{La}_{0.8}\text{Ba}_{0.2}\text{MnO}_3$. Sedangkan bagi senyawa $\text{BaO}_6(\text{Fe}_{1.7}\text{Mn}_{0.15}\text{Ti}_{0.15}\text{O}_3)$, berturut-turut adalah 312 nm, 173 nm dan 90 nm. Kecenderungan yang sama juga terjadi pada evaluasi distribusi ukuran kristalit yang diperoleh melalui teknik WPPM. Ukuran rata-rata kristalit partikel senyawa $\text{La}_{0.8}\text{Ba}_{0.2}\text{MnO}_3$ dan $\text{BaO}_6(\text{Fe}_{1.7}\text{Mn}_{0.15}\text{Ti}_{0.15}\text{O}_3)$ pasca tahapan sintesis melalui teknik pemaduan mekanik masing-masing adalah 112 nm dan 202 nm. Jangkauan lebar distribusi ukuran kristalit menyempit disertai dengan pengecilan ukuran rata-rata kristalit untuk kedua jenis partikel yaitu masing-masing 60 nm dan 77 nm pasca destruksi secara ultrasonik dalam durasi 5 jam. Dengan demikian, melalui destruksi lanjut secara ultrasonik telah diperoleh ukuran rata-rata partikel yang sama dengan ukuran rata-rata kristalitnya. Material hasil pencampuran partikel kedua jenis material memperlihatkan serapan gelombang mikro dalam rentang frekuensi 8 – 12 GHz dengan nilai reflection loss antara -17,75 dB dan -24,5 dB diperoleh pada komposisi dengan fraksi massa senyawa $\text{BaO}_6(\text{Fe}_{1.7}\text{Mn}_{0.15}\text{Ti}_{0.15}\text{O}_3)$ sebesar 70 %. Pada rentang frekuensi ini, nilai reflection loss lebih ditentukan oleh senyawa magnetik $\text{BaO}_6(\text{Fe}_{1.7}\text{Mn}_{0.15}\text{Ti}_{0.15}\text{O}_3)$.

In this paper, we presented results of research activities on the synthesis of microwave absorbing materials made of a mixture between $\text{BaO}_6(\text{Fe}_{1.7}\text{Mn}_{0.15}\text{Ti}_{0.15}\text{O}_3)$ and $\text{La}_{0.8}\text{Ba}_{0.2}\text{MnO}_3$ particles. The particles are nanometer in size which was synthesized through mechanical alloying process followed by the ultrasonic destruction. Both types of material are single phase as confirmed by their respective X-ray diffraction pattern. Results of particle size distribution measurements by Particle Size Analyzer (PSA) showed that sintered mechanically alloyed $\text{La}_{0.8}\text{Ba}_{0.2}\text{MnO}_3$ and $\text{BaO}_6(\text{Fe}_{1.7}\text{Mn}_{0.15}\text{Ti}_{0.15}\text{O}_3)$ materials have the mean particle size of respectively 733 nm and 714 nm. Both have a normal distribution with a relatively wide range size ~ 600 nm. The particle size distribution width for both types of material are

progressively narrowed accompanied by successive reduction in mean sizes to 354 nm, 168 nm and 70 nm for $\text{La}_{0.8}\text{Ba}_{0.2}\text{MnO}_3$ after ultrasonic destruction for 1, 3 and 5 hours respectively. For $\text{BaO}_6(\text{Fe}_{1.7}\text{Mn}_{0.15}\text{Ti}_{0.15}\text{O}_3)$ the mean sizes were respectively 312 nm, 173 nm and 90 nm. The same trend was also applied for the crystallite size distribution obtained through the WPPM technique. The mean crystallite size for $\text{La}_{0.8}\text{Ba}_{0.2}\text{MnO}_3$ and $\text{BaO}_6(\text{Fe}_{1.7}\text{Mn}_{0.15}\text{Ti}_{0.15}\text{O}_3)$ materials respectively 112 nm and 202 nm. The crystallite size distribution width for both types of materials were also narrowed as the destruction time was extended to 5 hrs with the mean crystallite size was respectively 60 nm and 77 nm. Thus, further destruction of the particles by means of ultrasonic has led to almost an equal value between mean particle and crystallite sizes. Materials which made of mixing the two types of material particles exhibited absorption of microwaves in the frequency range 8-12 GHz with reflection loss values ranging between -17.75 dB and - 24.5 dB. These values were obtained in a mixed material in which the mass fraction of $\text{BaO}_6(\text{Fe}_{1.7}\text{Mn}_{0.15}\text{Ti}_{0.15}\text{O}_3)$ was 70%. In this frequency range, the reflection loss value is governed by the magnetic $\text{BaO}_6(\text{Fe}_{1.7}\text{Mn}_{0.15}\text{Ti}_{0.15}\text{O}_3)$ component.