Studi komparasi metode sintesis wet-mixing dan sol-gel terhadap sifat magnetik material perovskite manganite La0,7Ba0,1Ca0,1Sr0,1MnO3 = A comparison study between sol-gel and wet-mixing synthesis method on magnetic properties of perovskite manganite material La07Ba0.1Ca0.1Sr0.1MnO3

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Abstrak

Pada penelitian ini telah dipelajari efek metode sintesis terhadap fenomena magnetik material perovskite manganite La0,7Ba0,1Ca0,1Sr0,1MnO3 (LBCSMO). Sampel telah disintesis menggunakan metode Wet-Mixing (WM) dan Sol-Gel (SG) dengan temperatur kalsinasi dan sintering yang sama. Analisis X-Ray Difractometer (XRD) menunjukkan bahwa kedua sampel memiliki fasa tunggal dengan struktur Rhombohedral dan space group R-3c. Hasil Scanning Electron Microscopy (SEM) menunjukkan bahwa sampel WM memiliki ukuran grain yang lebih kecil dibandingkan sampel SG. Karakterisasi Energy Dispersive X-ray Spectroscopy (EDS) dengan metode elemental mapping mengonfirmasi homogenitas sampel. Karakterisasi X-Ray Photoemission Spectroscopy (XPS) juga mengonfirmasi elemen yang terkandung dari kedua sampel dengan terdeteksinya spektrum core level La 3d, Ba 3d, Ca 2p, Sr 3d, Mn 2p, dan O 1s. Metode sintesis yang berbeda menyebabkan perbedaan parameter struktur dan ukuran grain yang memengaruhi sifat magnetik sampel. Hal tersebut ditunjukkan oleh perbedaan karakteristik transisi fasa magnetik. Pada sampel WM terjadi slow magnetic transition dibandingkan sampel SG yang dibuktikan dari kurva transisi yang lebih landai. Perbedaan ini dapat dijelaskan dengan teori interaksi Double-Exchange (DE) dan model Core-Shell. Nilai temperatur Curie (𝑇𝐶) sampel WM dengan nilai 316 K sedangkan nilai sampel SG sebesar 330 K.
Analisis critical behavior menggunakan metode Modified Arrott Plot (MAP), Kouvel-Fisher (KF), dan Critical Isotherm (CI) juga menunjukkan perbedaan nilai critical exponents (𝛽, 𝛾 dan 𝛿) sebagai akibat perbedaan metode sintesis. Nilai critical exponents sampel WM mendekati nilai model Mean-field theory (KF: 𝛽 = 0,476; γ = 1,029; 𝛿 = 3,096), sedangkan untuk sampel SG mendekati nilai model Tricritical mean-field (KF: 𝛽 = 0,262; 𝛾 = 1,165; 𝛿 = 5,447). Perbedaan metode sintesis juga memengaruhi nilai perubahan entropi magnetik (-∆𝑆𝑀) dan magnetoresistance sampel. Nilai -ΔSM pada medan magnet 𝜇0𝐻 = 5 T adalah 3,16 dan 4,89 J/kg.K untuk masingmasing sampel WM dan SG. Nilai Low Field Magnetoresistance (LFMR) pada nilai medan magnet 𝜇0𝐻 = 0,1 T sekitar 9,1 % untuk sampel SG pada temperatur 108 K dan 7,6 % untuk sampel WM pada temperatur 110 K. Karakterisasi electron spin resonance (ESR) menunjukkan bahwa transisi fasa magnetik juga dipengaruhi spin-lattice dan spinspin relaxation. Selain itu, karakterisasi ESR mengonfirmasi ketidakhomogenan medan magnetik lokal dan phase separation (PS) antara fasa feromagnetik dan paramagnetic.
......The effects of the synthesis method on the magnetic phenomenon of perovskite manganite La0.7Ba0.1Ca0.1Sr0.1MnO3 (LBCSMO) have been investigated. Samples were synthesized using the Wet-Mixing (WM) and Sol-Gel (SG) method with the same temperature of calcination and sintering. The X-Ray Diffraction (XRD) analysis showed that both samples had a single phase with a Rhombohedral structure

with an R-3c space group. SEM characterization exhibited the grain size of the WM sample smaller than the SG sample. Energy Dispersive X-ray Spectroscopy (EDS) characterization with the elemental mapping method confirms the homogeneity of the sample. The results of XRay Photoemission Spectroscopy (XPS) characterization shows the core level spectrum of La 3d, Ba 3d, Ca 2p, Sr 3d, Mn 2p, and O 1s which confirms the elements contained in both samples. The different synthesis methods lead to different structure parameters and grain sizes which affect the magnetic properties of the samples. It is indicated by the difference in the characteristics of the magnetic phase transition. The WM sample shows a slow magnetic transition compared to the SG sample, which showed by a broaden transition curve. The different magnetic properties of both samples can be explained by Double-Exchange interaction and Core-Shell Model. The Curie temperature (𝑇𝐶) values for each sample were around 315 and 330 K for WM and SG samples, respectively.
Critical behaviour analysis using the Modified Arrott plot (MAP), the Kouvel-Fisher (KF) method, and Critical Isotherm (CI) showed crossover critical exponent values (𝛽, γ, and 𝛿). The critical exponent values of the WM sample close to Mean-field theory (KF: 𝛽 = 0.476; 𝛾 = 1.029; 𝛿 = 3.096), whereas for the SG sample close to Tricritical mean-field model (KF: 𝛽 = 0.262; 𝛾 = 1.165; 𝛿 = 5.447). The different synthesis methods also affect the value of magnetic entropy change (-∆𝑆𝑀) and magnetoresistance. The estimated - ∆𝑆𝑀 at the magnetic field 𝜇0𝐻 = 5 T are 3.16 and 4.89 J/kg.K for WM and SG samples, respectively. Both samples showed Low Field Magnetoresistance (LFMR) phenomenon is 9.1% for the SG sample at 108 K and 7.6% for the WM sample at 110 K at the magnetic field 𝜇0𝐻 = 0.1 T. Electron spin resonance (ESR) characterization shows that magnetic phase transitions are also influenced by spin-lattice and spin-spin relaxation. ESR characterization also confirms the inhomogeneity of the local magnetic field and phase separation (PS) between the ferromagnetic and paramagnetic phase.