# SINTESIS DAN KARAKTERISASI SENYAWA PEROVSKIT $(1-x)BaTiO_3$-$(x)BiFeO_3$ MENGGUNAKAN METODE LELEHAN GARAM

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# ABSTRACT


**SYNTHESIS AND CHARACTERIZATION OF PEROVSKITE COMPOUNDS (1-*x*)$BaTiO_3$-(*x*)$BiFeO_3$ USING THE MOLTEN-SALT METHOD**

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Advances in technology and industry are increasing the need for more efficient energy storage components. Among the current energy storage devices, dielectric capacitors exhibit higher discharge power density and fast charge-discharge, making them potentially applicable to devices that require large amounts of power in a short period of time. $BaTiO_3$ is considered as one of the most potential materials for dielectric capacitors because it has a high dielectric constant and low dielectric loss. However, it is known that $BaTiO_3$ has poor low efficiency since its normal ferroelectric behavior. In this study, $BiFeO_3$ was substituted into the $BaTiO_3$ matrix to study the effect in dielectric properties and energy storage performances. Perovskite compounds (1-*x*)$BaTiO_3$-(*x*)$BiFeO_3$ with $x$ = 0, 0.05, 0.1, 0.15 and 0.2 have been successfully synthesized using the molten-salt method with a mixture of NaCl/KCl salt with a mole ratio of salt and product of 5:1. The synthesized compounds were characterized using X-ray Diffraction (XRD) to analyze phase purity, Scanning Electron Microscope (SEM) to study morphology, Raman Spectroscopy to analyze vibrational bonding modes, Ultraviolet-Visible Diffuse Reflectance Spectroscopy (UV-Vis-DRS) to examine band gap energy, an LCR-meter to measure dielectric properties, and a Ferroelectric Tester Unit to determine ferroelectric polarization values and energy storage parameters. XRD data confirmed that all perovskite compounds exhibit a single phase, with a structural transformation toward a cubic phase, as evidenced by the disappearance of the (200) diffraction peak. This change was also confirmed by the c/a parameter approaching 1 based on Le Bail refinement results. Structural analysis from the Raman spectra proved that the product compound with composition variation $x$ = 0 had a tetragonal *P*4*mm* phase (low symmetry), which became pseudocubic (high symmetry) with increasing $BiFeO_3$ composition ($x$ = 0.05–0.2). Band gap energy analysis using UV-Vis-DRS showed a decrease in band gap energy with increasing $x$. SEM analysis revealed a porous and uneven pellet surface, indicating low density due to suboptimal compaction. Dielectric property analysis using the LCR-meter showed a ferroelectric to paraelectric phase transition peak ($T_c$) that tended to increase with increasing $x$. Ferroelectric property analysis using the Ferroelectric Tester Unit showed that all samples had hysteresis loops, confirming ferroelectric behavior at room temperature. Electrical property analysis showed a tendency for increased conductivity with the addition of $BiFeO_3$ composition ($x$), due to the presence of unpaired electrons ($3d^5$) from the $Fe^{3+}$ cation. The energy storage efficiency of pure $BaTiO_3$ ($x$ = 0) was calculated to be 32.7% and decreased to 9.9% at $x$ = 0.2. These results indicate that the synthesized compounds have limitations in their application as dielectric capacitor materials.



***Keywords**: Perovskite, ferroelectric, energy storage, molten-salt method, Le Bail Refinement.*