SINTESIS DAN KARAKTERISASI SENYAWA PEROVSKIT $Na_{0,25}Bi_{0,25+x}Ba_{0,5-x}Ti_{1-x}Fe_xO_3$ MENGGUNAKAN METODE LELEHAN GARAM SERTA POTENSINYA SEBAGAI BAHAN KAPASITOR DIELEKTRIK

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ABSTRACT

SYNTHESIS AND CHARACTERIZATION OF PEROVSKITE COMPOUNDS $Na_{0,25}Bi_{0,25+x}Ba_{0,5-x}Ti_{1-x}Fe_xO_3$ USING MOLTED SALT METHOD AND ITS POTENTIAL AS A DIELECTRIC CAPACITOR MATERIAL

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The development of technology in various sectors such as electric vehicles, medical devices, and electronics has increased the need for reliable and efficient energy storage systems. One of the devices that shows great potential to meet this need is the dielectric capacitor, which allows fast and repeated charge and discharge processes. Dielectric capacitors use ferroelectric materials as the active storage component because they can undergo spontaneous polarization. One of the ferroelectric materials widely studied for this purpose is perovskite compounds with the general formula ABO_3. In this study, perovskite compounds $Na_{0.25}Bi_{0.25+x}Ba_{0.5-x}Ti_{1-x}Fe_xO_3$ with variations of x = 0.02, 0.04, 0.06, 0.07, 0.08, and 0.10 were synthesized using the molten salt method. A mixture of KCl and K_2SO_4 salts in a eutectic ratio of 3:1 was used as the reaction medium, with a salt-to-precursor molar ratio of 2:1. Phase purity analysis using XRD showed that the perovskite compounds with x = 0.02, 0.04, 0.06, and 0.07 were single-phase products, while secondary phases were found at higher x compositions. Le Bail refinement analysis showed that the single-phase samples had an orthorhombic structure (*Pnma*), and the unit cell volume decreased with increasing x. This decrease suggests that smaller Bi^{3+} ions successfully substituted Ba^{2+} ions in the structure. The Raman spectrum shows a shift and broadening of the vibration peaks of the A-O and B-O bonds, indicating a change in the local structure due to the cation substitution. Furthermore, the presence of more Fe^{3+} cations indicates a new vibration mode of the octahedral BO_6 structure, indicating a local Fe-O-Fe order. The band gap energy (E_g) decreases with increasing x composition, this can be caused by the formation of new energy levels or new subbands originating from the d orbitals of Fe^{3+} ions. The SEM characterization results show an increase in the morphological structure, accompanied by a more homogeneous grain size and increased inter-grain density. The ferroelectric property of the samples was confirmed by the appearance of the ferroelectric–paraelectric transition (T_m) in the dielectric curve. As x increased, the T_m peak became broader and showed frequency-dependent relaxation, indicating relaxor ferroelectric behavior. The ferroelectric hysteresis (P–E) curve also showed a remanent polarization (P_r) with a slim loop shape, supporting the presence of polar domains typical of relaxor materials. The energy storage parameters, including recoverable energy density (W_{rec}) and storage efficiency (η), were calculated from the area of the P–E loop. The composition $Na_{0.25}Bi_{0.32}Ba_{0.43}Ti_{0.93}Fe_{0.07}O_3$ (x = 0.07) showed the best performance, with a W_{rec} value of 22.73 mJ/cm³ and an efficiency (η) of 81.10%, making it the optimum composition due to its dominant relaxor character and high energy storage capability.

Keywords : Perovskite, ferroelectric, dielectric capacitor, molten salts, *Le Bail refinement*