

Abstract

In this study, the double-layered Aurivillius phase $\text{CaBi}_2\text{Ta}_2\text{O}_9$ (CBT) and $\text{PbBi}_2\text{Ta}_2\text{O}_9$ (PBT) were synthesized ~~by a using the~~ hydrothermal method ~~using and~~ NaOH as a mineralizer. XRD analysis confirmed that the CBT and PBT compounds were successfully synthesized using ~~this the~~ hydrothermal method. The crystal structure analysis using Le Bail refinement reveals that the orthorhombic structure with ~~a~~ $A2_1am$ space group were adopted for both samples. The morphology of both samples was examined by SEM, which ~~showed demonstrated~~ anisotropic plate-like grains. It ~~is was~~ found that the different ionic radii of *A*-site cations (Ca^{2+} and Pb^{2+}) strongly affect the structural, electrical and optical properties of ~~the~~ Aurivillius phase. The occupation of smaller Ca^{2+} cations induced the higher structural distortion, ~~and hence which~~ results in ~~the~~ higher bandgap (E_g) energy ~~as well as the and~~ ferroelectric transition temperature (T_c) of CBT, compared ~~than to those~~ that PBT.

Keywords: Aurivillius phase, hydrothermal method, refinement, dielectric properties, optical properties.

Introductions

In the past few decades, ~~the~~ bismuth layer structured ferroelectrics (BLSFs) have received ~~special increasing~~ attention, ~~primarily~~ due to their appealing physical properties such as high dielectric permittivity, diffuse phase transition, and piezoelectric properties []. They have ~~also~~ been ~~used applied~~ successfully in a variety of electronic applications, including multilayer capacitors, sensors, actuators, transducers, and ~~memories—memory~~ applications. Aurivillius phases, which are part of the BLSF compounds, are of particular interest for ~~that this~~ multifunction, because they are ferroelectric, ~~and have possess~~ a large remanent polarization, and a low leakage current. ~~Because—Due to of~~ the need for a renewable and green source of energy, BLSF compounds have gained increasing attention as promising candidates for solar cell and electrocaloric (EC) cooling systems [1].

Structurally, the Aurivillius phases can be ~~figured—considered~~ as layered intergrowths of fluorite-like $[\text{Bi}_2\text{O}_2]^{2+}$ layers alternating with *n*-perovskite-like $[\text{A}_{n-1}\text{B}_n\text{O}_{3n+1}]^{2-}$ layers stacking along the *c*-axis. The *A* ~~is~~ typically ~~represents~~ monovalent, divalent, or trivalent cations with 12-fold coordination (e.g., Na^+ , Ca^{2+} , Pb^{2+} , Ba^{2+} , Sr^{2+} ,

Ln^{3+}) and ~~the B is represents~~ a transition metal cation with 6-fold coordination (e.g., Ti^{4+} , Nb^{5+} , Ta^{5+} , W^{6+}). The electrical properties of ~~the~~ Aurivillius phase have been thoroughly investigated in terms of the effect of $6s^2$ lone-pair electrons and the ionic radii of *A*-site cations constructing the Aurivillius structure []. The substitution of ~~the~~ *A*-site cation results in ~~the a~~ change ~~of in the~~ *B*-O bond distance and angles, and the latter affects the electrical properties of these materials to some extent.

To date, solid state reaction is the most common method for producing Aurivillius phases. However, ~~the~~ high-temperature sintering frequently causes the volatilization of Bi^{3+} , ~~which tends to be formed~~ impurities and requires the addition of excess Bi_2O_3 to synthesis procedures []. ~~It This~~ can be overcome by ~~using the~~ soft chemical methods such as ~~the~~ hydrothermal method, which involves heating a liquid-phase reaction medium and precursors in an autoclave at a low-temperature and high pressure. The benefits of ~~hydrothermal method this particular~~ include lower energy costs due to the reaction's low temperatures, less pollution, simpler process equipment, ~~a~~ faster precipitation reaction rate, and ~~the~~ characteristically ~~produces production of~~ fine particles with a narrow size distribution []. Besides, it is ~~well well~~-known that compositional homogeneity and morphology have a significant impact on ~~the~~ physical properties []. However, there are ~~a~~ ~~limited number of few reports studies~~ on the hydrothermal preparation of CBT and PBT powders.

In ~~the present this~~ work, we have synthesized the double-layer Aurivillius compounds $CaBi_2Ta_2O_9$ and $PbBi_2Ta_2O_9$ using ~~a~~ hydrothermal method, ~~which that~~ has not previously been reported ~~in the related literature~~. ~~The A~~ comparative study ~~of on~~ different sizes of *A*-site cation (Ca^{2+} and Pb^{2+}) ions on structure, morphology, dielectric and optical properties ~~has been was~~ carried out. The Ca^{2+} ~~is was~~ chosen to represent ~~a the~~ smallest *A*-site cation usually used and the Pb^{2+} is a cation with $6s^2$ lone pair electrons, since both main factors ~~are were~~ expected to induce a ~~highly highly~~-distorted structure and high ferroelectricity in ~~the~~ Aurivillius family phase.