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ABSTRACT

Multiferroic Aurivillius phase ceramics (APCs) have attracted significant attention due to their unique layered structure and potential for room-temperature multiferroic behavior. In this study, we investigate the multiferroic properties of a series of APCs with the general formula $B_{5-2x}L_{0.75}F_{0.25}C_{1-x}O_{18}$ (where $B = \text{Bi, Pb, Sr, Ba}$ and $L = \text{La, Ce, Pr, Nd, Sm, Eu, Gd}$). The structure consists of alternating layers of perovskite and rock-salt layers. The multiferroic behavior is characterized by the presence of both ferroelectric (FE) and ferromagnetic (FM) orders. The ferroelectricity is induced by the displacement of the B-site ions, while the ferromagnetism is attributed to the presence of the Fe²⁺ ions. The room-temperature multiferroic behavior is observed in the $B_{5-2x}L_{0.75}F_{0.25}C_{1-x}O_{18}$ system, with the multiferroic behavior being enhanced as the x value increases. The multiferroic behavior is characterized by the presence of both ferroelectric (FE) and ferromagnetic (FM) orders. The ferroelectricity is induced by the displacement of the B-site ions, while the ferromagnetism is attributed to the presence of the Fe²⁺ ions. The room-temperature multiferroic behavior is observed in the $B_{5-2x}L_{0.75}F_{0.25}C_{1-x}O_{18}$ system, with the multiferroic behavior being enhanced as the x value increases.

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Multiferroic Aurivillius phase ceramics (APCs) have attracted significant attention due to their unique layered structure and potential for room-temperature multiferroic behavior. In this study, we investigate the multiferroic properties of a series of APCs with the general formula $B_{5-2x}L_{0.75}F_{0.25}C_{1-x}O_{18}$ (where $B = \text{Bi, Pb, Sr, Ba}$ and $L = \text{La, Ce, Pr, Nd, Sm, Eu, Gd}$). The structure consists of alternating layers of perovskite and rock-salt layers. The multiferroic behavior is characterized by the presence of both ferroelectric (FE) and ferromagnetic (FM) orders. The ferroelectricity is induced by the displacement of the B-site ions, while the ferromagnetism is attributed to the presence of the Fe²⁺ ions. The room-temperature multiferroic behavior is observed in the $B_{5-2x}L_{0.75}F_{0.25}C_{1-x}O_{18}$ system, with the multiferroic behavior being enhanced as the x value increases. The multiferroic behavior is characterized by the presence of both ferroelectric (FE) and ferromagnetic (FM) orders. The ferroelectricity is induced by the displacement of the B-site ions, while the ferromagnetism is attributed to the presence of the Fe²⁺ ions. The room-temperature multiferroic behavior is observed in the $B_{5-2x}L_{0.75}F_{0.25}C_{1-x}O_{18}$ system, with the multiferroic behavior being enhanced as the x value increases.

$B_{5.25}L_{0.75}F_1C_{3.0}O_{18}$
 (BLFC) P L A P C, D^{14,17} BLFC = 4 = 5 A . N
 F, A a b , P EM (a-b) M ,
 BLFC a b A P
 A in situ I H I I
 N F AL, D , O , U K.
 () , P A BLFC (50, 70 100, 300, 500 H).
 BLFC FE T BLFC H , B₆F₃O₁₈
 (973 K).¹³ F 2() P-E I-E
 BLFC P I-E
 BLFC P .^{21,22} I-E
 BLFC 10 μC/ F 2() (FC) BLFC BLFC
 F 2() 200 O BLFC BLFC
 B2cb A A
 A A₂₁ ,
 A B2cb a = 5.4530(2) Å, b = 5.4427(1) Å,
 c = 50.670(2) Å A_{21am} a = 5.4651(6) Å,
 b = 5.3943(6) Å, c = 41.487(2) Å
 F P (://

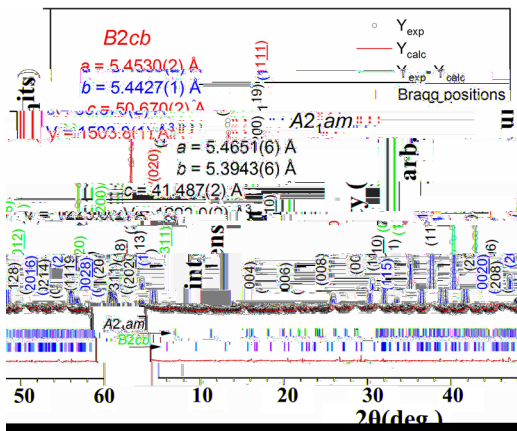


FIG. 1. XRD patterns of B2cb and A21am phases.

BLFC = 4 = 5 A . N
 BLFC F 1 EM (a-b) M ,
 F . 1
 D. ED 1.4 % (F . 2
 1)
 F, C, O, C₂F₄
 A B₅F_{0.5}C_{0.5}O₁₅.¹⁶
 BLFC (50, 70 100, 300, 500 H).
 1060 K FE T BLFC H , B₆F₃O₁₈
 (973 K).¹³ F 2() P-E I-E
 BLFC P I-E
 BLFC P .^{21,22} I-E
 BLFC 10 μC/ F 2() (FC) BLFC BLFC
 F 2() 200 O BLFC BLFC

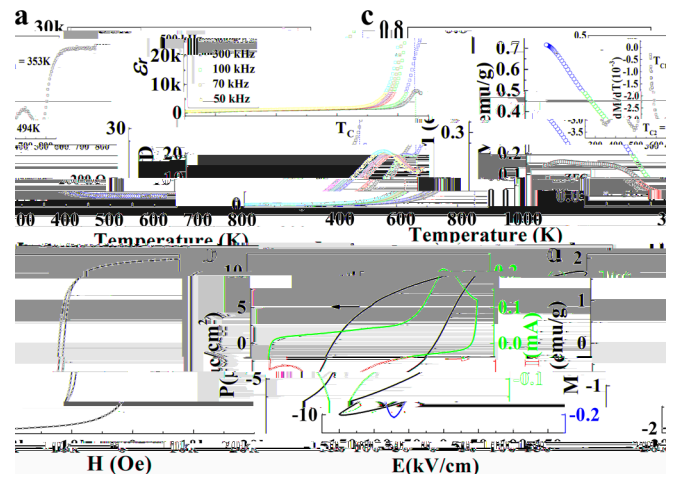


FIG. 2. Temperature dependence of dielectric loss (tan δ) and piezoelectric coefficient (P) for BLFC. (a) tan δ vs Temperature (K) from 0 to 1000 K, showing peaks at 353 K and 494 K. (b) P (C/cm) vs Temperature (K) from 0 to 1000 K, showing a peak at 353 K. (c) Piezoelectric coefficient (P) in C/cm vs electric field (E) in kV/cm, showing a hysteresis loop. The piezoelectric coefficient ranges from -0.2 to 0.8 C/cm.

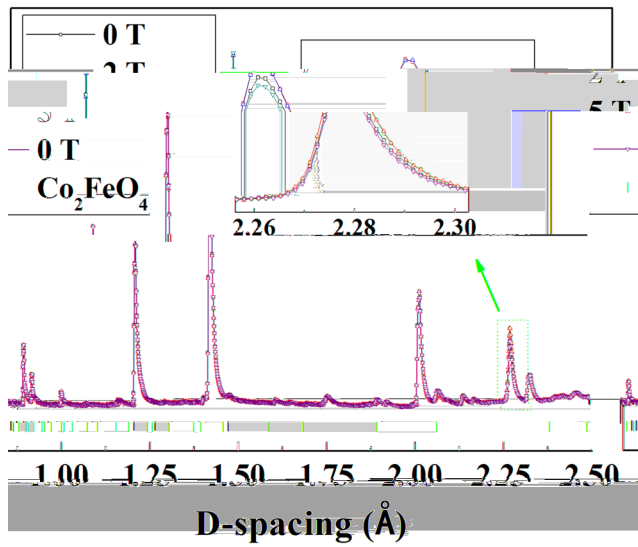


FIG. 4. XRD patterns of Co_2FeO_4 at 0 T and 5 T. The inset shows a magnified view of the 2.26–2.30 Å region. A green arrow points to a peak at approximately 2.28 Å.

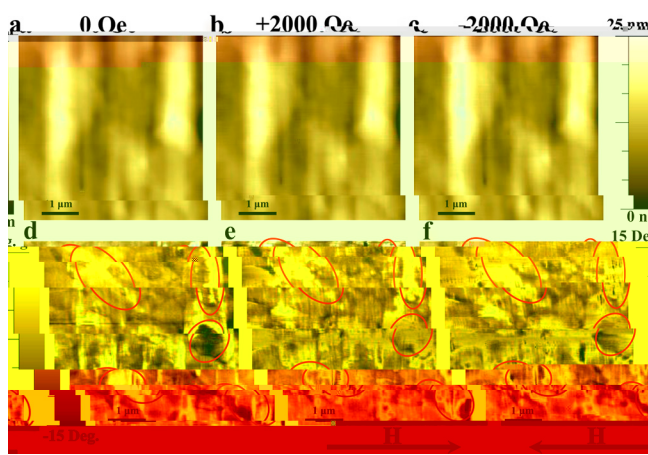
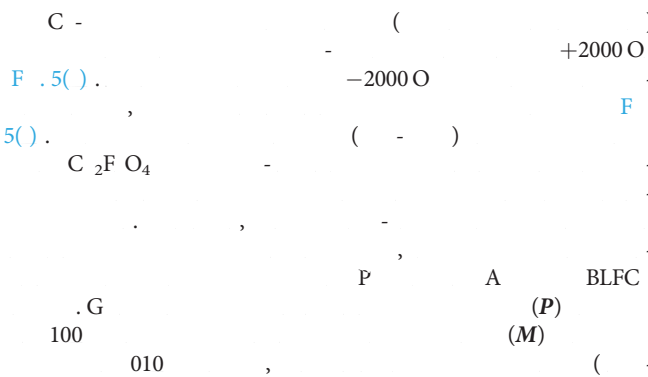


FIG. 5. MFM images of Co_2FeO_4 at 0 Oe, +2000 Oe, and -2000 Oe. The images show magnetic domains with a color scale from 0 nT to +2000 Oe. Labels (P) and (M) indicate positive and negative magnetic charges.

$T = P \times M$
 BLFC
 I , A BLFC
 F
 $\text{C}^{3+} \text{O} \text{C}^{3+}, \text{F}^{3+} \text{O} \text{C}^{3+}$
 $\text{F}^{3+} \text{O} \text{F}^{3+}$
 A , C / F
 EM (ED)
 BLFC
 D . M , P D . K , D.
 D I H I I N , AL,
 D , O K.
 A E D F
 G A A (G N . 2/
 0038/20), C (G N . K2015-0602006), N FC (G
 N . 11474138 11834005). A
 E M P (EM P)
 P IND54 N EM P
 EM P E PAME E

DATA AVAILABILITY

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