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ABSTRACT

Multiferroic behavior is observed in layer-structured Aurivillius phase ceramics $B_{5.25}L_{0.75}F_2C_3O_{18}$ and $B_5F_2C_3O_{18}$ at room temperature. The $B_{5.25}L_{0.75}F_2C_3O_{18}$ ceramic shows a magnetic transition at $T_M \approx 250$ K and a ferroelectric transition at $T_F \approx 200$ K. The $B_5F_2C_3O_{18}$ ceramic shows a magnetic transition at $T_M \approx 200$ K and a ferroelectric transition at $T_F \approx 150$ K. The multiferroic behavior is attributed to the presence of $B_5F_2C_3O_{18}$ phase in the $B_{5.25}L_{0.75}F_2C_3O_{18}$ ceramic. The *in situ* X-ray diffraction (XRD) and Raman spectroscopy results show that the $B_{5.25}L_{0.75}F_2C_3O_{18}$ ceramic has a layered structure with $B_5F_2C_3O_{18}$ phase in the interlayer. The $B_5F_2C_3O_{18}$ phase is a multiferroic phase with a magnetic transition at $T_M \approx 200$ K and a ferroelectric transition at $T_F \approx 150$ K. The multiferroic behavior is attributed to the presence of $B_5F_2C_3O_{18}$ phase in the $B_{5.25}L_{0.75}F_2C_3O_{18}$ ceramic.

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B_{2cb} $a = 5.4530(2)$ 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

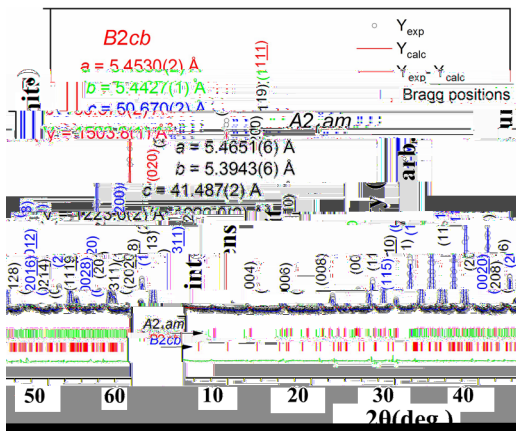


FIG. 1. XRD patterns of B2cb and A21am phases.

BLFC $a = 5.4530(2)$ Å, $b = 5.4427(1)$ Å, $c = 50.670(2)$ Å
 BLFC $a = 5.4651(6)$ Å, $b = 5.3943(6)$ Å, $c = 41.487(2)$ Å

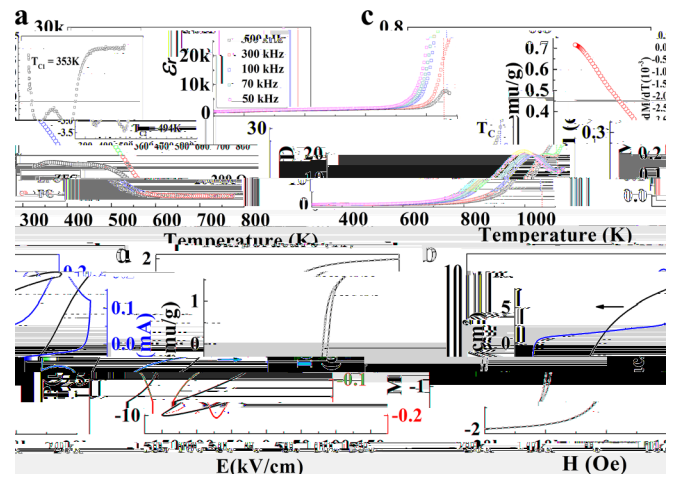


FIG. 2. (a) Temperature dependence of magnetization (M) for various frequencies. (b) Temperature dependence of the Curie temperature (T_c) and coercive field (H_c). (c) Temperature dependence of the remanent magnetization (M_r) and coercive field (H_c).

BLFC $B_6FC_3O_{18}$ (526 K).²³

$F^{3+} O F^{3+}, C_a^{3+} O C_a^{3+}, F^{3+} O C^{3+}$ (.

ED FC $2 \sim 353 K$.

$C_2F_2O_4$ (460 K) $16.235 /$ 25 $0.22 0.32$ 1.4%

$M = 1.85$ $F_a \cdot 2()$ I_a $M H$

$2 (F_a \cdot 3)$ $425 K$ 1.58 0.27 ED

$F_a \cdot 3$ $F^{3+} O C^{3+}$ $ab initio$

(DF) $(A P)$ $F = 2$ $C = 3$ F_a C_a $(GGA)+$ I

$F \cdot 3()$ F^{3+} C^{3+} $(3.1$ $2.1 \mu_B/a$ $)$

$(0.1 \mu_B/a)$ $F O_6$ $C O_6$ F/C $F \cdot 3()$

F_a O_a F^{3+} C^{3+} $E_{FM} - E_{AFM}$

$= -144.1$ (FM) FM

H_a 43.5 $(\dots, 504.6 K)$ FC/FC $F \cdot 2()$ $a b$

010 $F_a \cdot 4$ I_a

BLFC PFM $BLFC$ $399 O$ F P

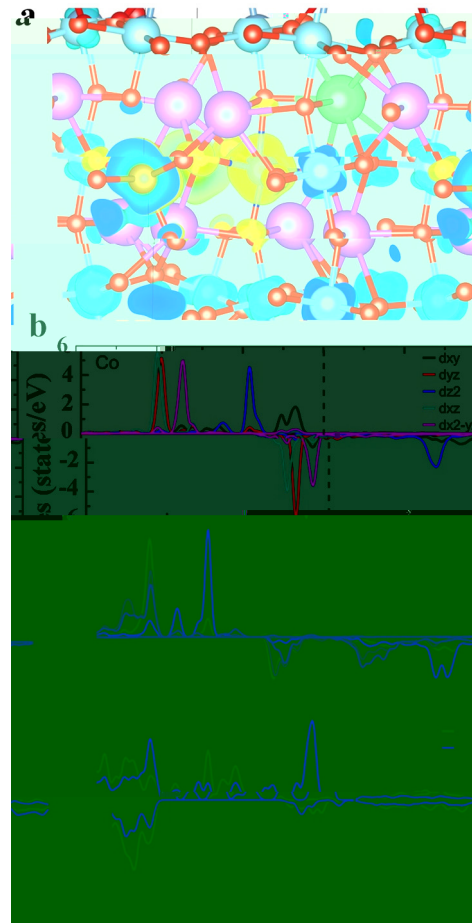


FIG. 3. (a) Crystal structure of BLFC showing layers of B₆FC₃O₁₈ and C₂F₂O₄. (b) Density of states (DOS) plot for Co, showing contributions from dxy, dyz, dz², dxz, and dx²-y² orbitals.

$F_a \cdot 4$ $(0_a 1 20)$

$2 \le H < 5_a$ $M H$ $F_a \cdot 2()$ $3_a F_a$

$F_a \cdot 5$ $BLFC$ $P F M$ $399 O$ F P

$5()$ A PFM $BLFC$ P

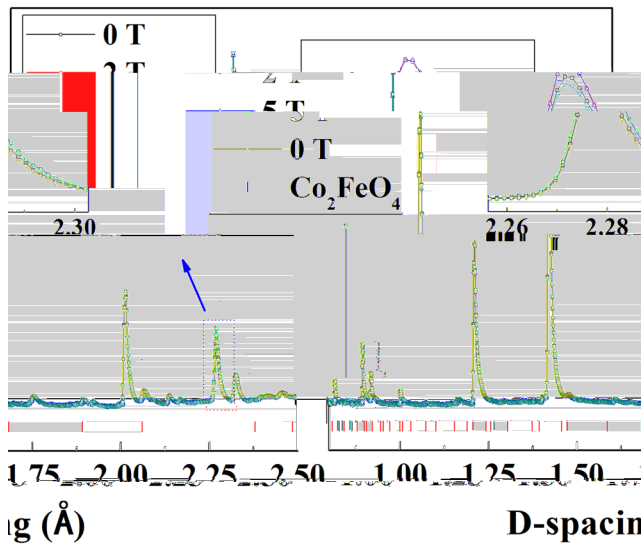


FIG. 4. XRD patterns of Co_2FeO_4 at 0 T and 5 T. The inset shows the Rietveld refinement of the 2.26 Å peak.

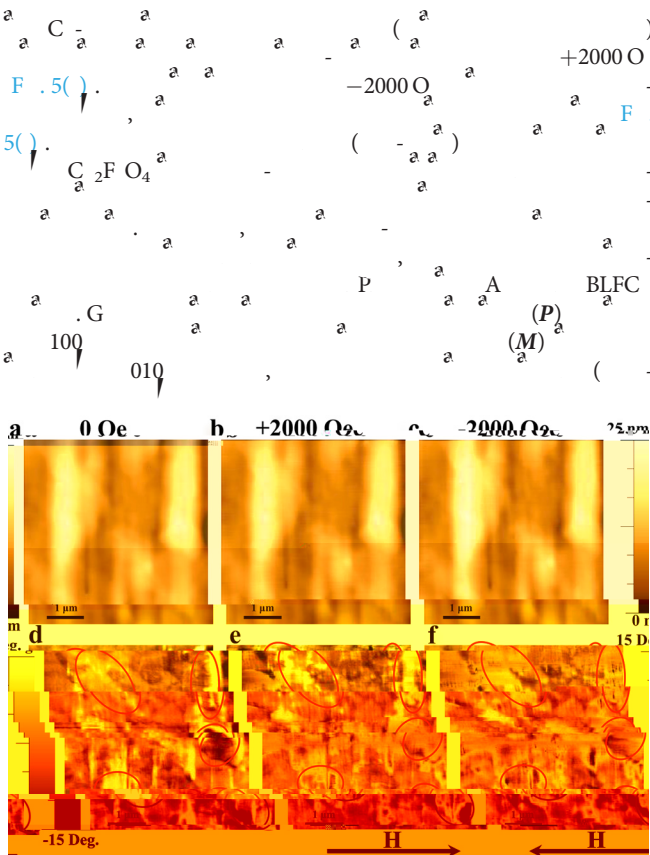


FIG. 5. MFM images of Co_2FeO_4 at different magnetic fields. (a) 0 Oe, (b) +2000 Oe, (c) -2000 Oe. The bottom row shows magnified views (d-f) of the surface.

$T = P \times M$
 BLFC
 $\text{C}^{3+} \text{O}_2 \text{C}^{3+}$, $\text{F}^{3+} \text{O}_2 \text{C}^{3+}$, $\text{F}^{3+} \text{O} \text{F}^{3+}$,
 C_2F
 EM (ED)
 BLFC
 D. M., P., D., K., D.
 I H I I N, AL,
 D, O, K.
 A E D F
 G A A A (G N 2/
 0038/20), C (G N K2015-0602006), N FC (G
 N 11474138 11834005). A P (EM P)
 P IND54 N M P (EM P)
 EM P E AME E

DATA AVAILABILITY

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