




Room-temperature multiferroic behavior in layer-structured Aurivillius phase ceramics

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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

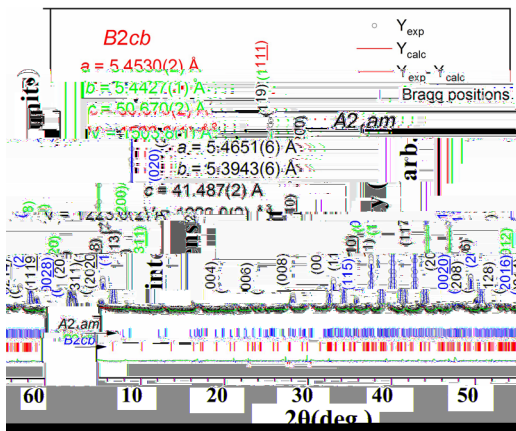


FIG. 1. XRD patterns of B2cb and A21am phases.

BLFC $a = 5.4530(2)$ Å, $b = 5.4427(1)$ Å, $c = 50.670(2)$ Å
 A_{21am} $a = 5.4651(6)$ Å, $b = 5.3943(6)$ Å, $c = 41.487(2)$ Å

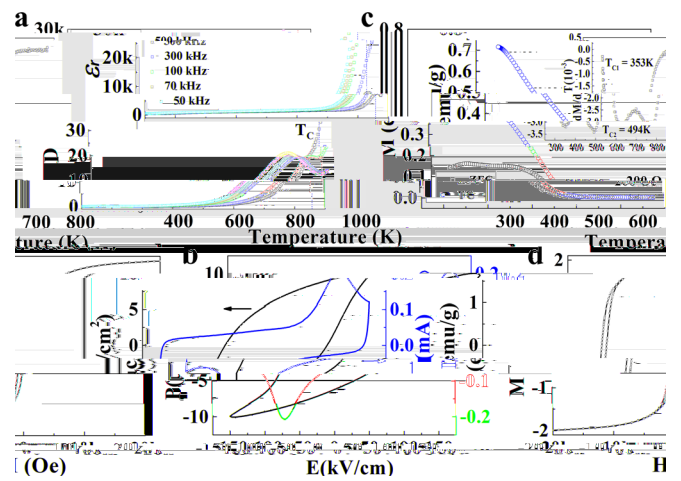


FIG. 2. (a) Temperature dependence of dielectric loss (tan δ) and dielectric constant (ε') for BLFC. (b) Temperature dependence of magnetization (M) for BLFC. (c) Temperature dependence of the derivative of magnetization (dM/dT) for BLFC. (d) Temperature dependence of the derivative of magnetization (dM/dT) for BLFC. (e) Temperature dependence of the derivative of magnetization (dM/dT) for BLFC. (f) Temperature dependence of the derivative of magnetization (dM/dT) for BLFC.

$\sim 494 \text{ K}$
 $B_6\text{FC}_{33}\text{O}_{18}$ (526 K).²³
 BLFC
 F^{3+} , O , F^{3+} , C^{3+} , O , C^{3+} , F^{3+} , O , C^{3+} (.
 ED
 $\sim 353 \text{ K}$
 $\text{C}_2\text{F}_2\text{O}_4$
 $\text{C}_2\text{F}_2\text{O}_4$ (460 K)
 (M) $\text{C}_2\text{F}_2\text{O}_4$
 $16.235 / .$ ²⁵
 $\text{C}_2\text{F}_2\text{O}_4$ 0.22 0.32 / ,
 $M = 1.85$ / , F_a $2(\)$. I
 M H
 $2(F_a \cdot 3)$
 425 K 1.58 / 0.27 / ,
 ED
 BLFC
 F_a 3
 (DF) F^{3+} O C^{3+} *ab initio*
 $(A P)$
 $F = 2$ $C = 3$ F_a C_a
 $(GGA) +$ I
 F_a $3(\)$, F^{3+} C^{3+} (3.1 $2.1 \mu_B/a$)
 $0.1 \mu_B/a$)
 F/C F_a $3(\)$.
 F^{3+} C^{3+}
 $(\)$
 $E_{\text{FM}} - E_{\text{AFM}}$
 $= -144.1$
 H_a 43.5 (. , 504.6 K) (FM) FM
 FC/FC F_a $2(\)$.
 010
 BLFC F_a 4
 PFM BLFC 399 O .
 $5(\)$. A P F

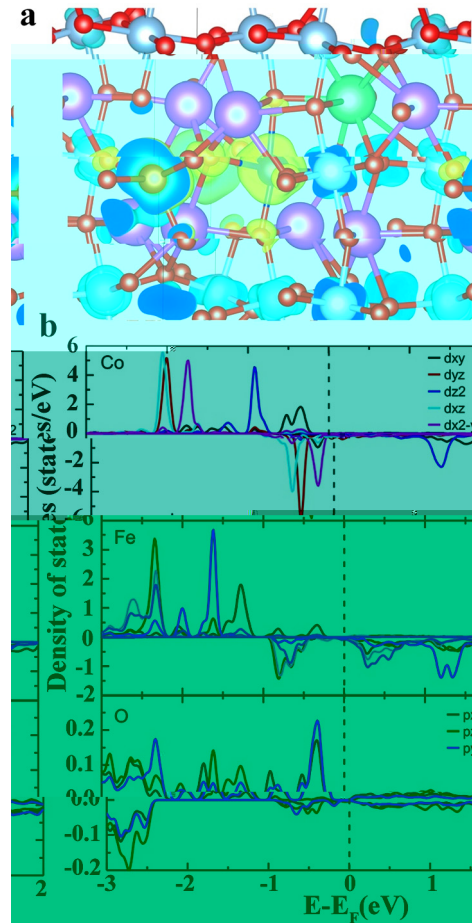


FIG. 3. (a) Crystal structure of BLFC ($a = b = c = 0.38 \text{ nm}$, $\alpha = \beta = \gamma = 90^\circ$), $B_6\text{FC}_{33}\text{O}_{18}$ ($a = b = c = 0.38 \text{ nm}$, $\alpha = \beta = \gamma = 90^\circ$), (a, b, c) (in \AA) $(0.38, 0.38, 0.38)$. (b) Density of states (DOS) for Co, Fe, and O atoms.

N
 I F_a 4 $(0_1 20)$
 $(2 \leq H < 5_a)$
 $M H$ F_a $2(\)$ $3_a F$
 F_a 5 BLFC P F M
 PFM BLFC 399 O .
 $5(\)$. A P F

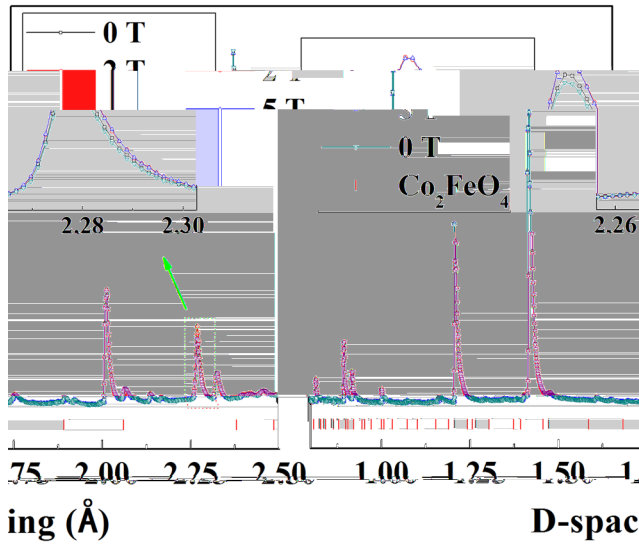


FIG. 4. XRD patterns of Co_2FeO_4 at 0 T and 5 T. The inset shows a magnified view of the peaks at 2.26 Å and 2.28 Å.

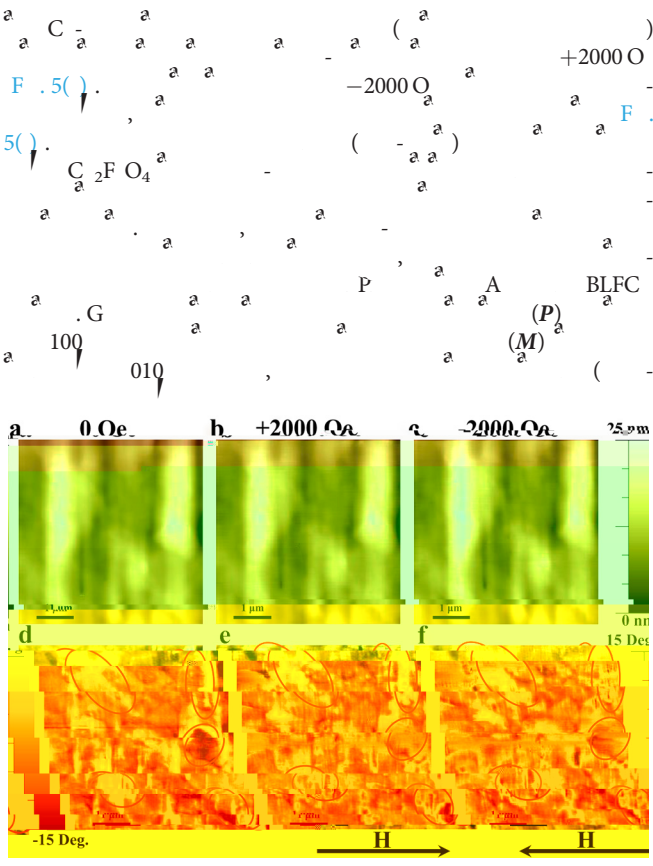


FIG. 5. MFM images of Co_2FeO_4 at 0 Oe, +2000 Oe, and -2000 Oe. The top row (a, b, c) shows MFM images with a 25.0 nm scale bar. The bottom row (d, e, f) shows corresponding phase images with a 15 nm scale bar. The phase images show circular features, likely vortices, with a -15 Deg. phase shift indicated.

$T = P \times M$
 BLFC
 $\text{C}^{3+} \text{O}_2 \text{C}^{3+}$, $\text{F}^{3+} \text{O}_2 \text{C}^{3+}$, $\text{F}^{3+} \text{O} \text{F}^{3+}$,
 $\text{C}_2\text{F}_2\text{O}_4$, C_2F
 EM (ED)
 BLFC
 D.M., P., D.K., D.
 I.H., I.I.N., AL.
 D., O., K.
 A.A.E., D.A.F., G.N. 2/0038/20, C (G.N. K2015-0602006), N.F.C (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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