

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

Cite as: Appl. Phys. Lett. **117**, 052903 (2020); <https://doi.org/10.1063/5.0017781>

Submitted: 09 June 2020 . Accepted: 25 July 2020 . Published Online: 07 August 2020

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~ 494 K (M/),
 $B_6F_2C_{18}O_{18}$ (526 K).²³
 BLFC
 $F^{3+} O F^{3+}, C^{3+} O C^{3+}, F^{3+} O C^{3+}$ (.
 ED).²⁴
 A FC ~ 353 K
 $C_2F_4O_4$ (460 K) (M) $C_2F_4O_4$ 16,25
 $16.235 / .25$, 0.22 0.32 / , 1.4 .%
 $C_2F_4O_4$ BLFC
 $M = 1.85 / , F . 2(1.1$, M H
 ~ 425 K 1.58 / . 0.27 / , ED
 BLFC
 A
 F_3
 $F^{3+} O C^{3+}$
 (DF) *ab initio*
 (A) H
 $\downarrow_F = 2$ $\downarrow_C = 3$ F C ,
 (GGA)+ \downarrow . I
 BLFC
 $F . 3(1, F^{3+} C^{3+} (3.1 2.1 \mu_B/ ,)$,
 $(0.1 \mu_B/)$.
 $F O_6 C O_6$
 () F/C
 F O / . F . 3(1.
 $F^{3+} C^{3+}$
 (. ,) (. ,)
 $E_{FM} - E_{AFM}$
 $= -144.1$.
 H , (FM)
 43.5 (. , 504.6 K), FM
 ~ 1 FC/FC . F . 2(1.)
 a b
 010
 BLFC
 I
 399 O .
 F .
 F -

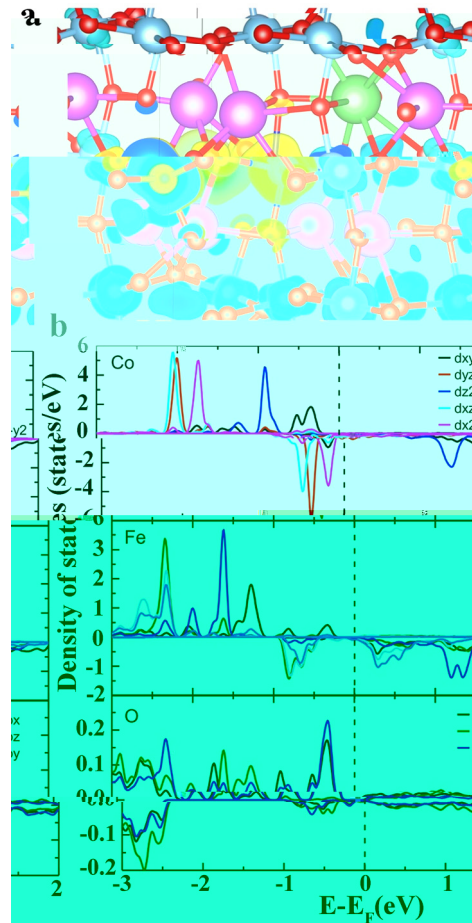


FIG. 3. (a) Crystal structure of BLFC. (b) Density of states (DOS) plots for Co, Fe, and O atoms, showing contributions from dxy, dyz, dz2, dxz, and dx2-y2 orbitals. The x-axis is E-E_f (eV) from -3 to 2, and the y-axis is Density of states (states/eV).

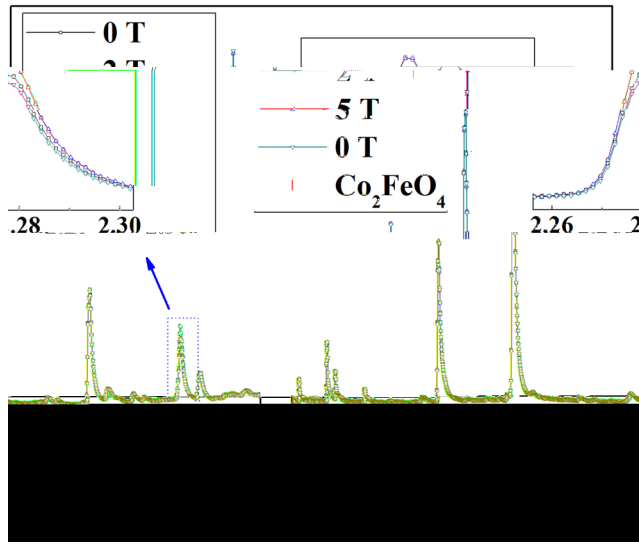


FIG. 4. XRD patterns of Co_2FeO_4 at 0 T and 5 T. The inset shows the zoomed-in view of the 2.26–2.30 2θ region. The blue arrow indicates the peak at 2.27 .

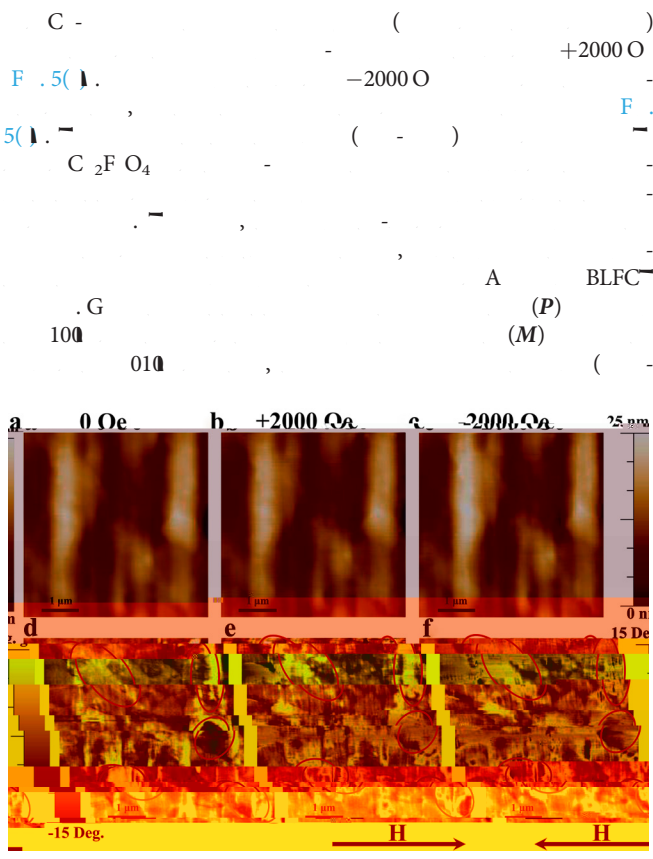


FIG. 5. HRTEM images and SAED patterns of Co_2FeO_4 at 0 Oe, +2000 Oe, and -2000 Oe. The scale bars are 1 μm and 25 nm. The SAED patterns show spots at 100 and 010 positions.

$T = P \times M$
 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 , 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 (EM)
 IND54 N EM
 EM E AME E

DATA AVAILABILITY

REFERENCES

1. E , N. D. M , J. F. , *N* **442**, 759 (2006).
2. N. A. , *N . M* **6**, 21 (2007).
3. M , J. H , L. C . N , *A . M* **23**, 1062 (2011).
4. L. F. H , O. C , J. B , J. L , C. H ,
 H , H , O. G , D. C. L , H. , K ,
 A. J. B , *A . F . M* **26**, 2111 (2016).
5. N. A. H , *J . C . B* **104**, 6694 (2000).
6. B. A , M : IL
 B_4O_{12} , A . K **1**(58), 499–512 (1949).
7. A. , G. K , M. M. K , *J . C*
M **11**, 3335 (1999).
8. N. , G. . K , *M . E . B* **108**, 194 (2004).
9. L. K , M , A. A , N. D , N. , M.
 E. , D. J , *J. A . C* **96**, 2339
 (2013).
10. L. J. M , G. , G. , K , A. M , L. C. J , C. N ,
 H. , *D* **45**, 14049 (2016).
11. J. F. , *N GA M* **5**, 72 (2013).
12. A. . B C. E , *B* **90**, 214109 (2014).
13. J. B. L. , H , G. H , G. . L , J. L , J. C , J. K. L ,
 A . L **96**, 222903 (2010).
14. M , C , L , *A . L* **95**, 082901 (2009).
15. L. J. , L. , J. D , A . L **101**, 122402 (2012).

- ¹⁶M. [redacted], [redacted], M. B. [redacted], A. [redacted] B. [redacted], J. [redacted] H. [redacted], [redacted], K. [redacted], L. K. [redacted], [redacted], M. [redacted], [redacted], C. [redacted], [redacted] H. [redacted], A. J. B. [redacted], *J. A. [redacted]* **112**, 073919 (2012).
- ¹⁷J. L. [redacted], H. [redacted], M. J. [redacted], [redacted], K. [redacted], [redacted], *J. A. [redacted]* **102**, 104107 (2007).
- ¹⁸M. G. C. [redacted], *Characterisation of Ferroelectric Bulk Materials and Thin Films* ([redacted], 2014), [redacted].
- ¹⁹[redacted], K. [redacted], J. M. [redacted], [redacted], G. [redacted], C. J. [redacted], H. [redacted], A. M. [redacted], J. C. [redacted], M. C. [redacted], I. A. [redacted], C. N. [redacted], C. J. [redacted], H. [redacted], *J. M. [redacted] C. [redacted]* **6**, 2733 (2018).
- ²⁰[redacted], K. [redacted], I. [redacted], G. [redacted], M. [redacted], C. J. [redacted], H. [redacted], *J. [redacted] C. [redacted]* **122**, 15733 (2018).
- ²¹L. J. [redacted], F. L. [redacted], [redacted], *J. A. [redacted] C. [redacted]* **97**, 1 (2014).
- ²²H. [redacted], F. I. [redacted], G. [redacted], H. N. [redacted], H. [redacted], [redacted], J. [redacted], [redacted], [redacted], G. [redacted], M. J. [redacted], *J. A. [redacted] D. [redacted]* **1**, 107 (2011).
- ²³J. [redacted], L. [redacted], [redacted], [redacted], [redacted], J. D. [redacted], [redacted], [redacted], A. [redacted], *[redacted] L. [redacted]* **101**, 012402 (2012).
- ²⁴B. [redacted], J. [redacted], J. C. [redacted], [redacted], L. [redacted], [redacted], [redacted], J. D. [redacted], [redacted], [redacted], A. [redacted], [redacted], *[redacted] L. [redacted]* **104**, 062413 (2014).
- ²⁵[redacted], M. [redacted], [redacted], N. B. [redacted], [redacted], [redacted], **11**, 719 (2009).