Applied Physics Letters

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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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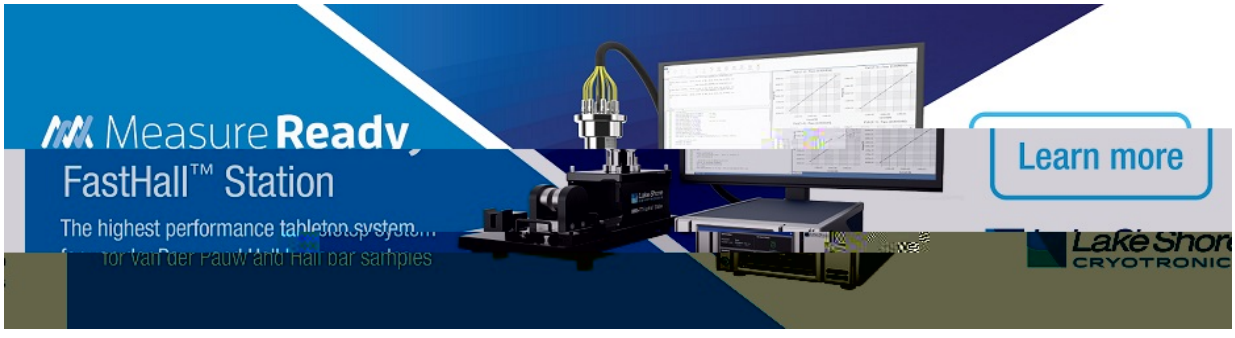

Applied Physics Letters ARTICLE scitation.org/journal/apl

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Published Online: 7 August 2020 · Corrected: 11 August 2020

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AFFILIATIONS

[1] G ... 430074, C ...
[2] I ... M ... A ... 47, K ... 04001, ...
[3] ... E ... M ... M ... L ... E1 4N ... K ...
[4] N ... K L ... D ... F ... C ... A ... E ... M ... 621900, C ...
[5] N ... L ... H ... 11 0L ... K ...
[6] E ... L ... F ... G 9 9 ... K ...
[7] ... L ... 730000, C ...

a) Email: ... @ ...
b) Author to whom correspondence should be addressed: ... @ ...

ABSTRACT

M ... . H ... , ... - ... [redacted] , ... - A ... , ... [redacted]D ... . H , A ... $B_{5.25}L_{0.75}FC\,{}_{3}O_{18}$ ... - ... . A ... , ... *in situ* ... - ... . F $^{3+}$ O F $^{3+}$, C $^{3+}$ O C $^{3+}$, F $^{3+}$ O C $^{3+}$ ... - ... . - ... . A ... , C /F ... - ... , ... - ... .

M ... (FE) ... (FM) ... , ... , ... [1 4] H ... , ... - ... - ... . [5] [redacted] , ... - A ... $(B_2O_2)^{2+}(A_{-1}B\,O_{3\,+1})^{2-}$ (A -, ... -, 12- - , B - ... - , ...)[6] ... B- ... - ... BFO_3 - ... . [7 11] .

A ... $B_5F\,{}_3O_{15}$ (= 4) $B_6F_2\,{}_3O_{18}$ (= 5), ... $B_4\,{}_3O_{12}$ BFO_3, ... FE FM ... . [12,13] B - ... C F B- , ... $B_5F_{0.5}C_{0.5}\,{}_3O_{15}$ (= 4) $B_6FC\,{}_3O_{18}$ (= 5) ... - ... . [14,15] H , ... [redacted]D - ... . [16] ... , ... - ... A ... .

I , A $B_{5.25}L_{0.75}F C_3O_{18}$ (BLFC) ( ). L , C , - F , .[14,17] D A - *a b* , BLFC *a b* . A - - , - .[18] - - A , *in situ* I H I I N , AL, D , O , K. F - ( ). , A BLFC . BLFC . , - , . F 1 - (D) BLFC . A *B2cb* - A , *A*2₁ , - A .[19,20] - *B2cb* $a = 5.4530(2)$ A, $b = 5.4427(1)$ A, $c = 50.670(2)$ A - $A2_1am$ $a = 5.4651(6)$ A, $b = 5.3943(6)$ A, $c = 41.487(2)$ A F (:// . .).

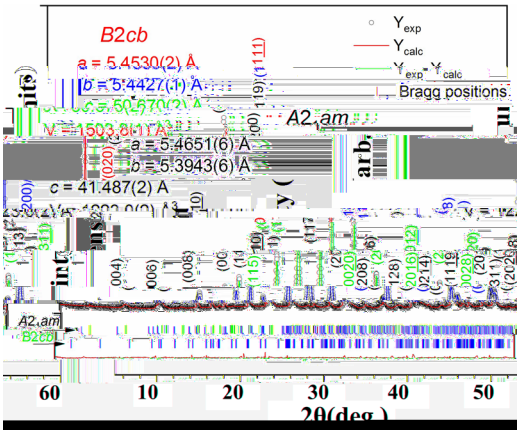

FIG. 1. -ray ffrati patter ft eB C p w er.

BLFC - A = 4 = 5 . N D' . F 1 EM - BLFC . - (*a–b*) . M , F . 1 . - 1.4 . %, D. ED (F . 2 1) F , C , O, - . - , $C_2F O_4$ - . - A $B_5F_{0.5}C_{0.5}O_{15}$.[16] F 2( ) BLFC (50, 70 100, 300, 500 H). - 1060 K FE *T* BLFC. H , BLFC $B_6F_2O_{18}$ (973 K).[13] F 2( ) *P–E* *I–E* BLFC - . - *I–E* ,[21,22] . - BLFC 10 μC/ ^{2}. F 2( ) - (FC) - (FC) 200 O BLFC. BLFC

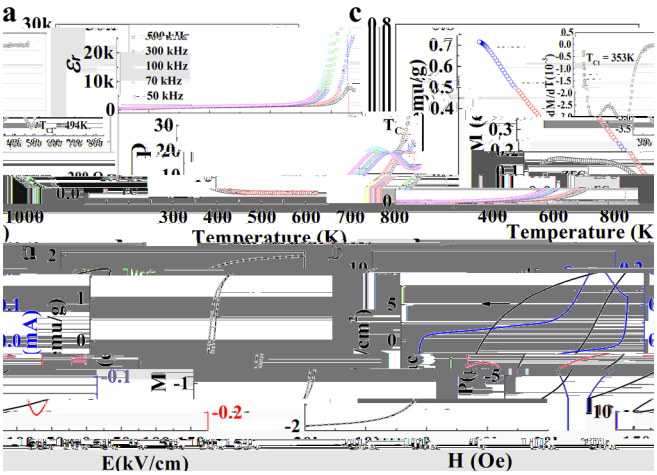

FIG. 2. (a) etempera re epe e e f t e reai e ieetri permittiy (a e) a ta et (w) f B C erami mea re perpe i ar ⊥] t t e P pre re ireti .( ) eP a ytere i p ft etext re B C erami mea re perpe i art t e P pre re ireti . e re em tradet e mai wi i arateriti f aferr eetri .( ) e tempera re epe e e f t e ma ėizai f r B C erami ⊥] i t e Z C/ C m e mea re i =200 e. ei ė w t e rt eri ai e f ma e- tizai M/ a af ti f tempera re.( ) e e epe e e f ma ėiza- ti a 300 f rt e B C ampe.

$_1 \sim 494$ K
(M/),
B_6FC $_3O_{18}$ (526 K).[23]
BLFC
F^{3+} O F^{3+}, C^{3+} O C^{3+}, F^{3+} O C^{3+} (.
).[24]
ED .
A FC $_2 \sim 353$ K
C_2FO_4. $_2$
C_2FO_4 (460 K) .[16,25]
(M) C_2FO_4
16 23.5 / .[25] , 1.4 .%
C $_2$ F O_4 0.22 0.32 / ,
BLFC
M = 1.85 / , F . 2( ). I
, M H
$_1$
$_2$ (F . 3).
425 K 1.58 / .
0.27 / ,
ED
. , BLFC
A .
F 3
F^{3+} O C^{3+}
(DF) *ab initio*
(A) . H
$_F = 2$ $_C = 3$ F C , ,
(GGA)+ . I
BLFC
F . 3( ), F^{3+} C^{3+} (3.1 2.1 μ_B/ ,),
O
(0.1 μ_B/).
F O_6 C O_6
( ) F /C
F O / . F . 3( ).
F ,
F^{3+} C^{3+} ,
(. .,) (. .,
) , .
, $E_{FM} - E_{AFM}$
= −144.1 .
H , . (FM)
43.5 (. ., 504.6 K), FM
$_1$ FC/FC . F . 2( ).
a b
. ,
010 .
F 4
BLFC . I
- , - ,

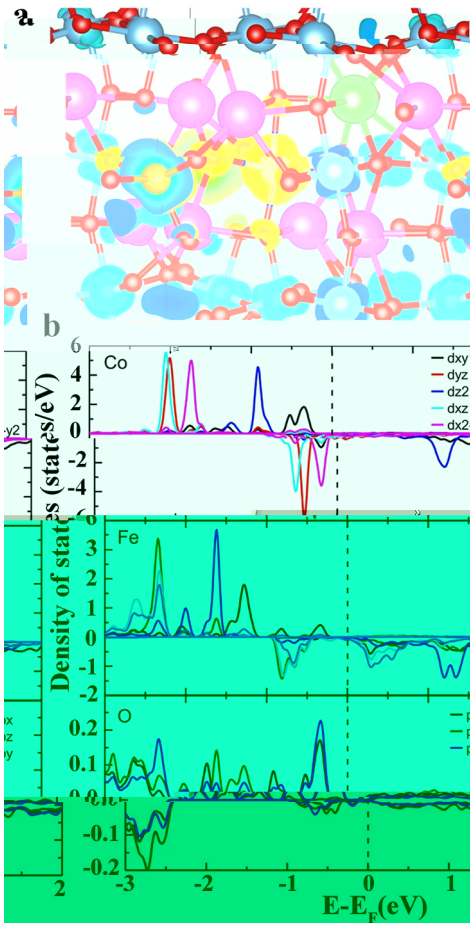

FIG. 3. (a) pi e ty ft e ytem (i fa e e e = 0.005) (re), Bi (pi), a (ree), i (i t e), C (ar e), a e (ye w) d m . ( ) A daie i peti ft e e ty f tdei e^{3+} C $^{3+}$.

. .N
, ,
. I F . 4,
A (0 1 20)
. ,
2 . F
($2 < H < 5$), ,
2 , M H F . 2( ) 3. F ,
.
F 5
BLFC F M
399 O .
FM BLFC , F .
5( ). A F -

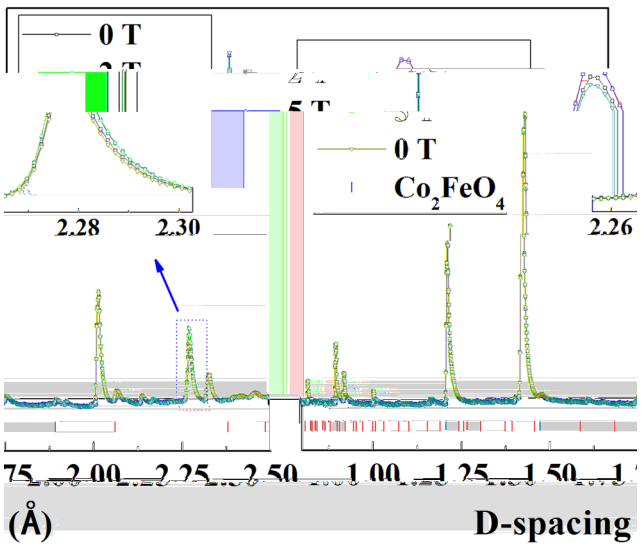

FIG. 4. er mtemperd re etr ffrati pater tai e f rt eB C erami d ffere t ma di e fr m 0, 2, a 5 a t e a t 0).

C - ( )
- +2000 O
F . 5( ). −2000 O -
, F .
5( ). (-)
C 2F O4 - -
- .
, -
, -
A BLFC
. G (*P*)
100 (*M*)
010 , (-

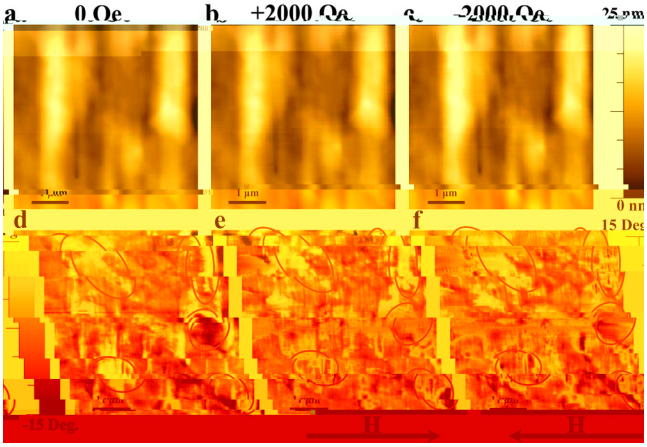

FIG. 5. err e etri mai wi i B C ert e appie ma di e (i para et t e fa e ft e ampe). (a) p rap y a ( ) eti a P M p a e d 0 e ( ) t p rap y a (e) eti a P M p a e d +2000 e a ( ) t p rap y a f) eti a P M p a e d −2000 e.

) $T = P \times M$
BLFC .
I , A BLFC -
. F
F 3+ O F 3+,
C 3+ O C 3+, F 3+ O C 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

.

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