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AFFILIATIONS

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

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ABSTRACT

M . H , - - . , - A , D . H , A $B_{5.25}L_{0.75}F$ C $_3O_{18}$ P . - A , *in situ* - . F^{3+} O F^{3+}, C^{3+} O C^{3+}, F^{3+} O C^{3+} - . - . A , C /F - - , .

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M (FE) (FM) , , . [1-4] H , - - . [5] , - (B $_2O_2)^{2+}$(A $_{-1}$B O$_3$ $_{+1})^{2-}$ (-, 12- - , B - -) [6] B- - B F O$_3$ - . [7-11] .

A B $_5$F $_3O_{15}$ (= 4) B $_6$F $_2$ $_3O_{18}$ (= 5), B $_4$ $_3O_{12}$ B F O$_3$, FE FM . [12,13] B - C F B- , B $_5$F $_{0.5}$C $_{0.5}$ $_3O_{15}$ (= 4) B $_6$F C $_3O_{18}$ (= 5) - A -, . [14,15] H , D - - . [16] , A .

I , A B $_{5.25}$L $_{0.75}$F C $_3$O$_{18}$ (BLFC) P (P). P L , C , F , .[14,17] D A a b , P BLFC a b . A . [18] . A , *in situ* I H I I N , AL, D , O , K. F ( ). , A BLFC P . BLFC P . , , . F 1 (D) BLFC . A $B2cb$ A , $A2_1$, 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 P (:// . .).

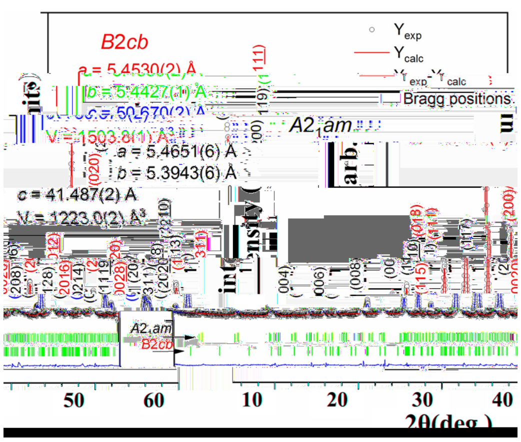

FIG. 1. - B .

BLFC - A = 4 = 5 . N D'. F 1 EM BLFC . - $(a–b)$ P . M , F . 1 . 1.4 . %, D. ED (F . 2 1) F , C , O, . , C $_2$F O$_4$. - A B $_5$F $_{0.5}$C $_{0.5}$ $_3$O$_{15}$.[16] F 2( ) BLFC P (50, 70 100, 300, 500 H). 1060 K FE T BLFC . H , BLFC B $_6$ $_3$F $_2$O$_{18}$ (973 K).[13] F 2( ) $P–E$ $I–E$ BLFC P . $I–E$,[21,22] . BLFC 10 μC/ ^{2}. F 2( ) (FC) - (FC) 200 O BLFC . BLFC

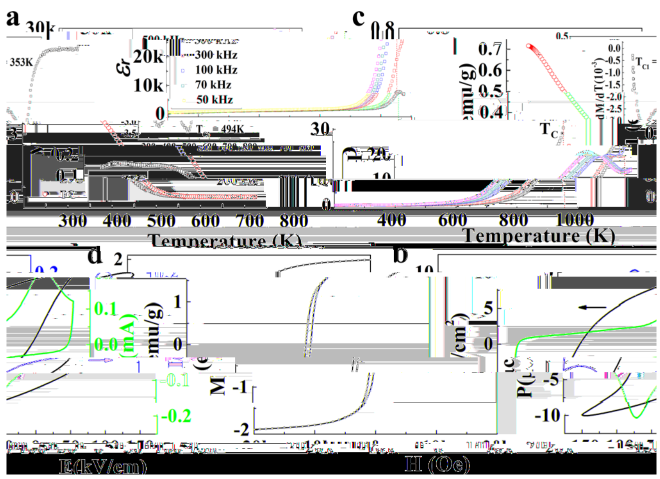

FIG. 2. ( ) ( ) ( ) B ⊥ P . ( ) P B P . . ( ) B ⊥ / = 200 . - M/ . ( ) - 300 B .

$_1 \sim 494$ K
(M/),
B $_6$F C $_3$O$_{18}$ (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 $_2$F O$_4$. 2 -
C $_2$F O$_4$ (460 K) .[16,25]
(M) C $_2$F O$_4$
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 P) . H
U $_F$ = 2 U $_C$ = 3 F C , ,
(GGA)+U . 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
- , - ,

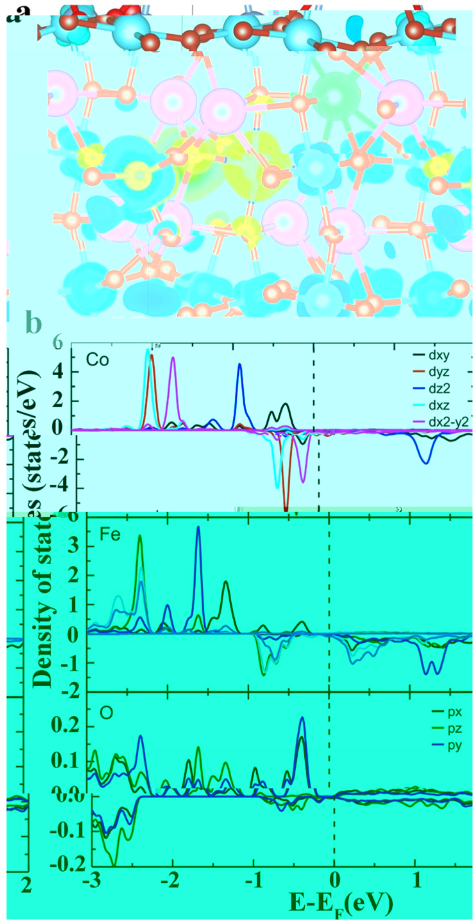

FIG. 3. ( ) (= 0.005) ( ), B ( ), ( ), ( ), (3+), 3+. ( ) . ( ) A

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

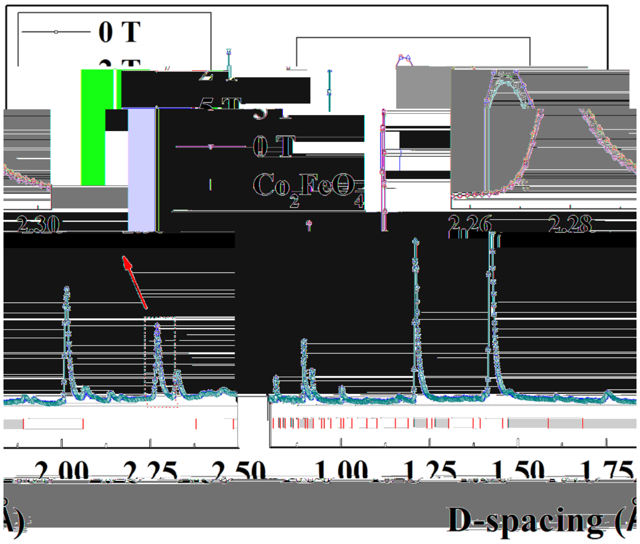

FIG. 4. - B (0, 2, 5 0).

C - ( ) - +2000 O F . 5( ) . −2000 O - , F . 5( ) . (-) C $_2$F O$_4$ - - - . , - , - P A BLFC . G (*P*) 100 (*M*) 010 , (-

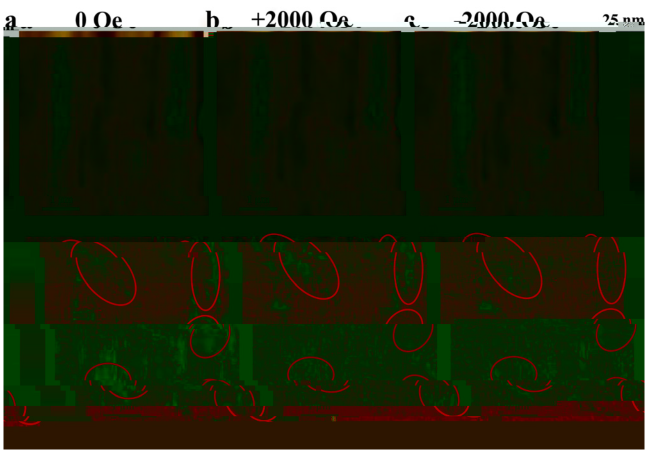

FIG. 5. B ( ). ( ) ( ) P M 0 ( ) ( ) P M +2000 ( ) ( ) P M −2000 .

) $T = P \times M$ 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 , 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 AME E .

DATA AVAILABILITY

.

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