Temperature identification on two 3D Mn(II) metal-organic frameworks : syntheses, adsorption and magnetism

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Supporting Information

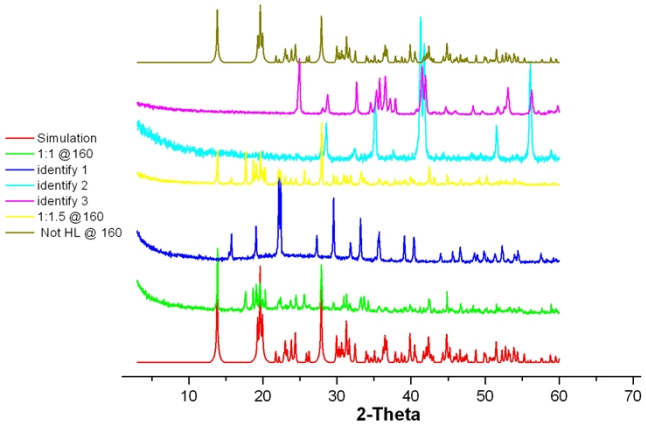

Fig. S1 Comparison of XRPD patterns of the simulated pattern from the single-crystal structure determination, the as-synthesized product and different condition products in compound **1**.

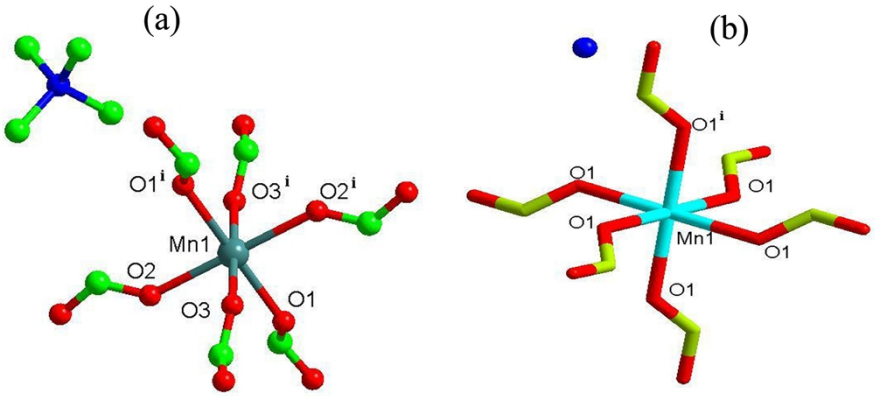

Fig. S2 View of the coordination modes of Mn(II) in **1** (symmetric code: (i) -x+1, -y, -z+1) and **2** (symmetric code: (i) -x+1/2, -y+1/2, -z+1/2).

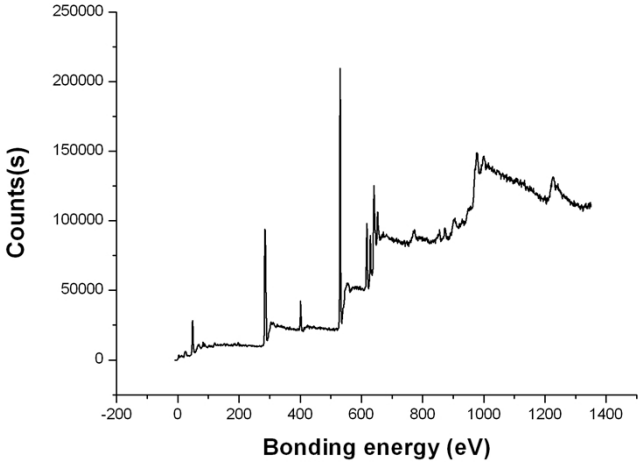

Fig. S3 the XPS pattern in **1**.

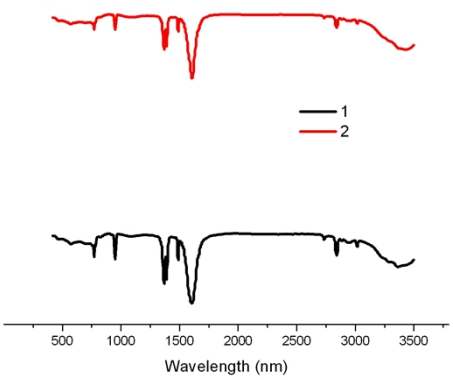

Fig. S4 View of the IR in **1** and **2**.

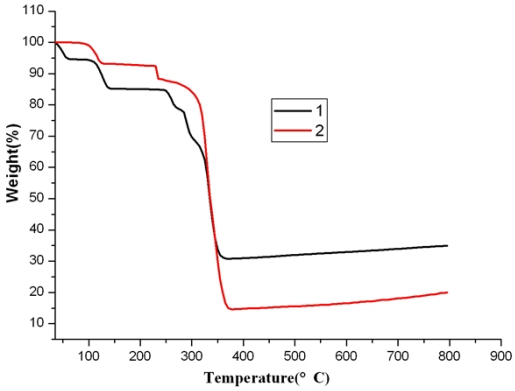

Fig. S5 View of the TGA in **1** and **2**.

Table S1 The Magnetism behavior of cationic @metal ion(formate)$_3$

Formula	Starting material	Magnetism feature	Refs
$[(CH_3)_2NH_2Co(HCOO)_3]$	PD-DMF $(CD_3)_2NCDO]$ in D_2O (2 mL) and $CoCl_2$	order–disorder-type ferroelectrics	1
$[(HONH_3)Mn^{II}(HCOO)_3]$	$Mn(ClO_4)_2{\cdot}6H_2O$, formic acid, triethylamine, hydroxylamine, hydrochloride	antiferromagnetic long-range ordering of spin canting	2
$[(dmenNH_2)Mn_2^{II}(HCOO)_6]$	$Mn(ClO_4)_2$. HCOOH, ammonia	spin-canted antiferromagnetism	3
[AmineH][$Mn^{II}(HCOO)_3$] AmineH =Methylamine, Ethylamine, Dimethylamine, Cyclotrimethyleneamine	$AmineH_2$,HCOOH and $MnCl_2$	long-range antiferromagnetism below 9 K with a slight non-collinear arrangement of the moments.	4
$K[Co(HCOO)_3]$	$CoCl_2{\cdot}6H_2O$ HCOOH, KCOOH	spin-canted antiferromagnet (T_N = 8.3 K) displaying two steps	5
$[Mn_3(HCOO)_6](CH_3OH)(H_2O)$	$CoCl_2{\cdot}6H_2O$ triethylamine HCOOH CH_3OH	antiferromagnetic with a spin canting arrangement below 2 K	6
[(Fmd)Ln(III)$(HCOO)_4$] Fmd^+=NH_2-CH-NH_2	Ln(III) salt cyclobutane-1,1-dicarboxylic acid, formamide	antiferromagnetic interaction	7
$[NH_4][Zn(HCOO)_3]$	$Zn(ClO_4){\cdot}6H_2O$, HCO_2H, ammonium formate	paraelectric-ferroelectric phase transition	8
$[NH_4][Mn(HCOO)_3]$	$MnCl_2$ HCO_2H, ammonium formate	paraelectric to ferroelectric phase transitions between 191 and 254 K	9
$[NH_4][M^{II}(HCOO)_3]$ (M= Mn, Co, Ni)	$Mn(ClO_4)_2$. HCOOH, ammonia	weak spontaneous magnetization	10
$[CH_3NH_2(CH_2)_2NH_2CH_3][M_2(HCOO)_6]$ (M = Mn^{II} and Co^{II})	$[dmenH_2][HCOO]_2$, $M(ClO_4)_2$	3D long-range antiferromagnetic	11

		ordering with small spin canting	
$[(CH_3)_2NH_2][Mn(HCOO)_3]$	$MnCl_2 \cdot 4H_2O$ DMF under 140°C	order-disorder type of ferroelectricity below 185 K.	12
$[(CH_3)_2NH_2][Mn(HCOO)_3]$	$MnCl_2 \cdot 4H_2O$, DMF, ethanol, 1 mL of water, formic acid under 140°C	a dielectric btransition around 190 K	13
$[(CH_3)_2NH_2][Mn(HCOO)_3]$	$MnCl_2 \cdot 4H_2O$ DMF under 140°C for 6 days	multiferroics with well separated magnetic and antiferroelectric transitions	14

References:

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The fitting equation for compounds **1** and **2**

$$\hat{H} = \sum_{nn} J.S_i.S_j$$

$$\frac{Ng^2\mu_B{}^2}{\chi J} = 3\theta + \sum_{n=1}^{\infty} \frac{C_n}{\theta^{N-1}}$$

$$\theta = \frac{kT}{JS(S+1)}$$