Electronic Supplementary Material (ESI) for Journal of Materials Chemistry C.

Observation of intrinsic florescence in cobalt ferrite magnetic nanoparticles by Mn^{2+} substitution and tuning of the spin dynamics by cation distribution

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Supplementry files:

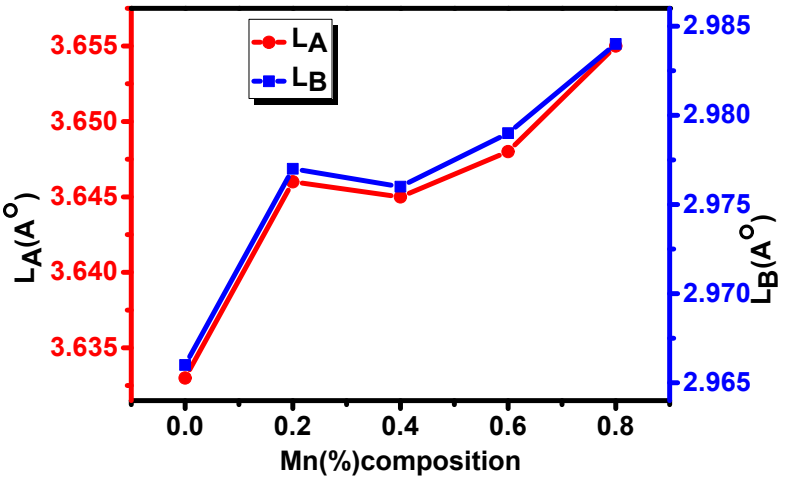

Figure S1: Variation of hopping length at A and B sites of $Co_{1-x}Mn_xFe_2O_4$ ($0.8 \leq x \leq 0$) nanoferrites with varying Mn^{2+} ions concentration.

Table S1: Details of the regents and molar ratio of the Mn, Fe and Co for different NFs samples.

Sample name $Mn_xCo_{1-x}Fe_2O_4$	Molar ratio of precursor used [$Fe(NO_3)_3.9H_2O$, $Co(NO_3)_2.6H_2O$ and $Mn(NO_3)_2.6H_2O$] Fe^{3+}:Co^{2+}:Mn^{2+}	PEG-400(ml)	NaOH (Sodium hydroxide) mmol
X=0	2 : 1 : 0	10	10
X=0.2	2 : 0.8 : 0.2	10	10
X=0.4	2: 0.6: 0.4	10	10
X=0.6	2 : 0.4 : 0.6	10	10
X=0.8	2 : 0.2 : 0.8	10	10

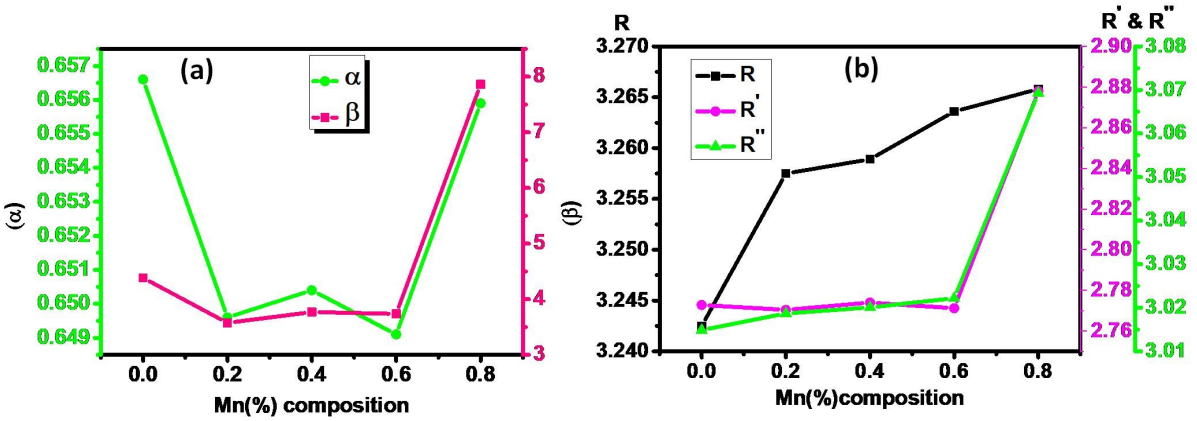

Figure S2: (a) Variation of degree of ionic packing fraction (α & β) (b) Variation of tetrahedral and octahedral edge, shared and unshared length of $Co_{1-x}Mn_xFe_2O_4$ (0.8≤x≤0) NF samples.

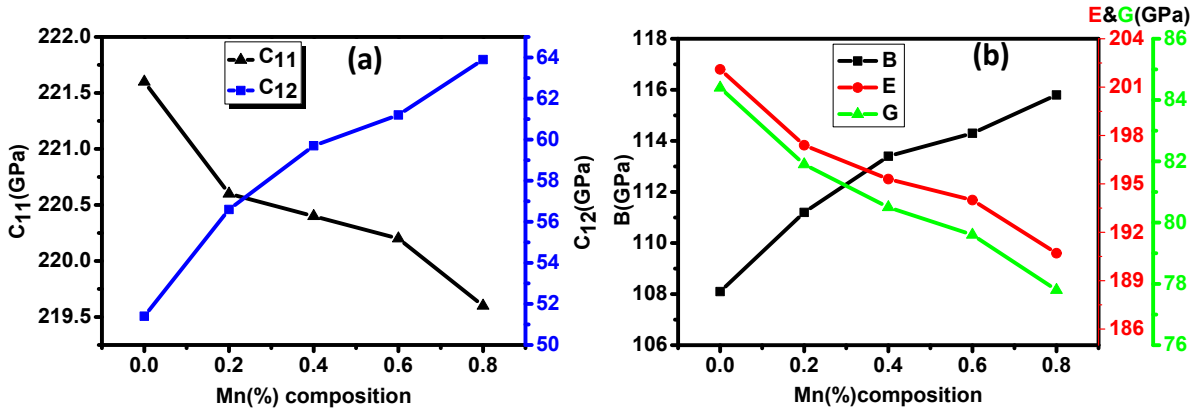

Figure S3: (a) Variation of elastic constant (C_{11}& C_{12}) (b) elastic moduli (Young's modulus, modulus of rigidity, and bulk modulus) for different $Co_{1-x}Mn_xFe_2O_4$ (0.8≤x≤0) NFs sample concentration.

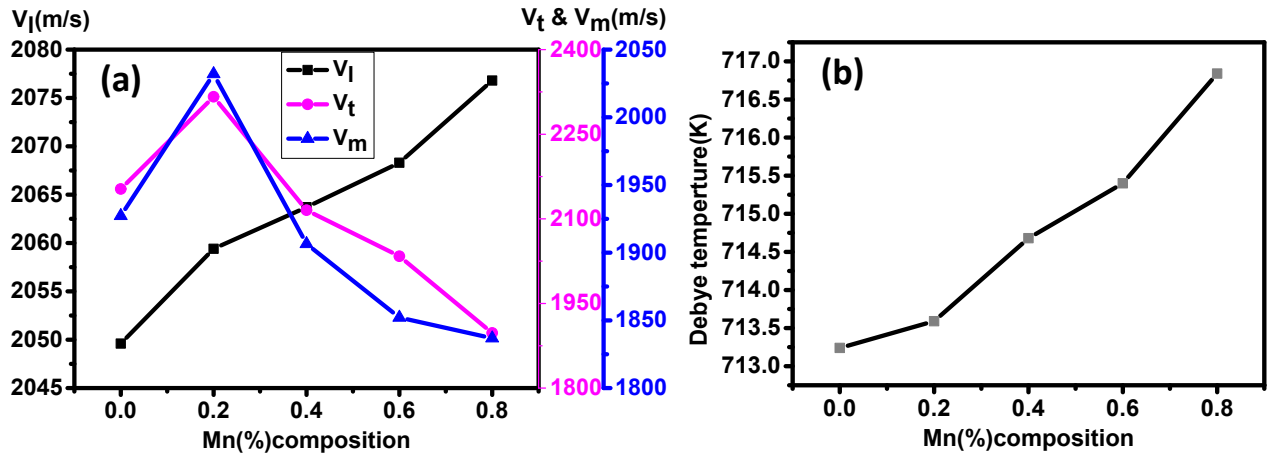

Figure S4: Variation of (a) different velocity i.e wave velocity, the longitudinal V_l(m/s), and transverse wave velocity V_t(m/s). (b) Debye temperature of $Co_{1-x}Mn_xFe_2O_4$ (0.8≤x≤0) NFs.

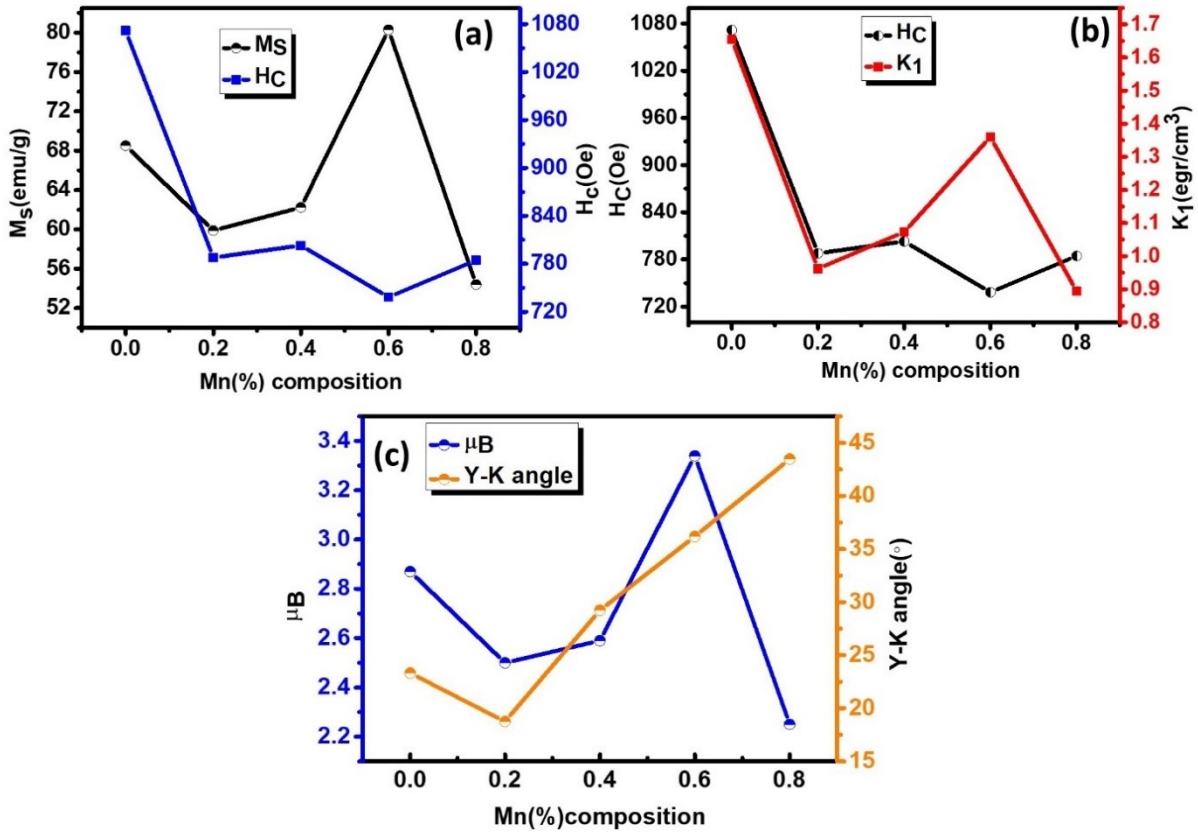

Figure S5: Variation of (a) saturation magnetization and coercivity (b) Variation of H_c vs and anisotropy constant (K_1) and (c) magnetic moments and Y-K angle (degree) of $Co_{1-x}Mn_xFe_2O_4$ ($0.8 \leq x \leq 0$) NFs.

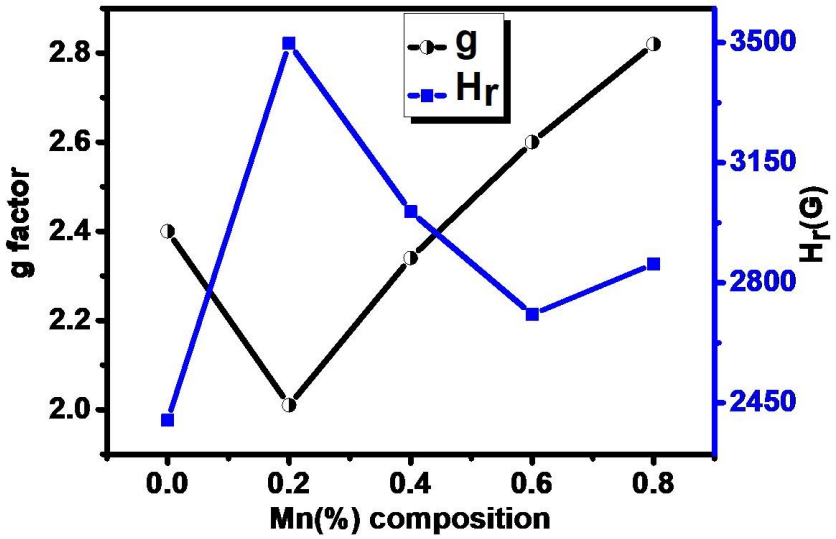

Figure S6: Variation of Lande's g- factor and resonance filed (H_r) of $Co_{1-x}Mn_xFe_2O_4$ ($0.8 \leq x \leq 0$) NFs.

Surface morphology (SEM) & Energy dispersive X-ray spectroscopy (EDS) study:

The surface morphology of the as-synthesized NF samples has been investigated by the SEM and the average gain size has been obtained. SEM is a non-destructive technique that provides key information about the morphology and grain size/distribution in the material system. The SEM micrograph of all the samples composition $Co_{1-x}Mn_xFe_2O_4$ ($0.8 \leq x \leq 0$) is shown in supplementary data

Figure-S7. The morphology of the particles plays a key role in determining the performance of the MNPs and is thus vital to understanding the properties of these materials systems.

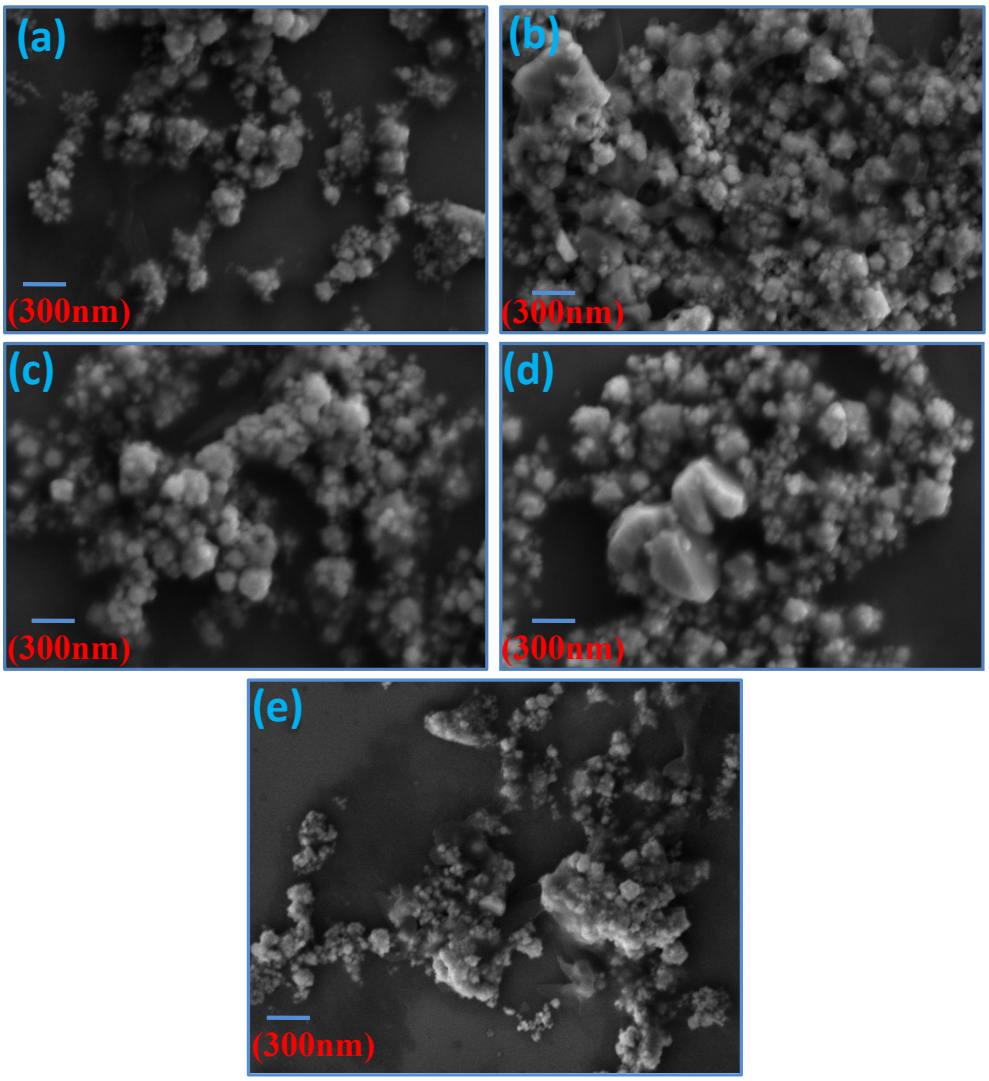

Figure S7: (a-e) SEM micrographs of the $Co_{1-x}Mn_xFe_2O_4$ ($0.8 \leq x \leq 0$, x =0.2) nanoferrites sample composition.

The SEM images indicate the spherical morphology of all the samples. The sample for the SEM investigation has been prepared by drop-casting on silicon substrate followed by drying in an oven overnight. Further, the average grain size has been calculated from the SEM micrograph using the linear intercept method (LIT) given as: $D_{sem} = \frac{1.5\,L}{MN}$, where D, L, M, and N are the average grain size, length of scale line, magnification, and many intercepts of Mn^{2+} ions doped CFO NFs[31]. The average grain size in the NF samples is found to be in the range of 30-40nm and it follows the same trend as of the crystallite size obtained from XRD and particle size obtained from the TEM analysis. The higher value of the grain size compared to the particle size obtained by the TEM can be correlated to the agglomeration in the MNPs due to large dipolar interaction. Generally, in SEM analysis of the NFs,

large agglomeration is perceived due to strong magnetic interaction among MNPs. The elemental composition and purity of all the constitute elements present in the as-synthesized NFs samples compositions were studied by EDS. The EDS spectra of pure CFO and $Co_{0.4}Mn_{0.6}Fe_2O_4$ NFs samples are depicted as shown in Figure-S8. It can be seen from the figure that in pure CFO, only peaks related to Fe, Co, and O is appearing whereas is shown in given EDS spectra. peak related to Mn is also appearing. The appearance of these peaks confirms the presence of all these elements in the sample and no additional peaks confirm the purity.

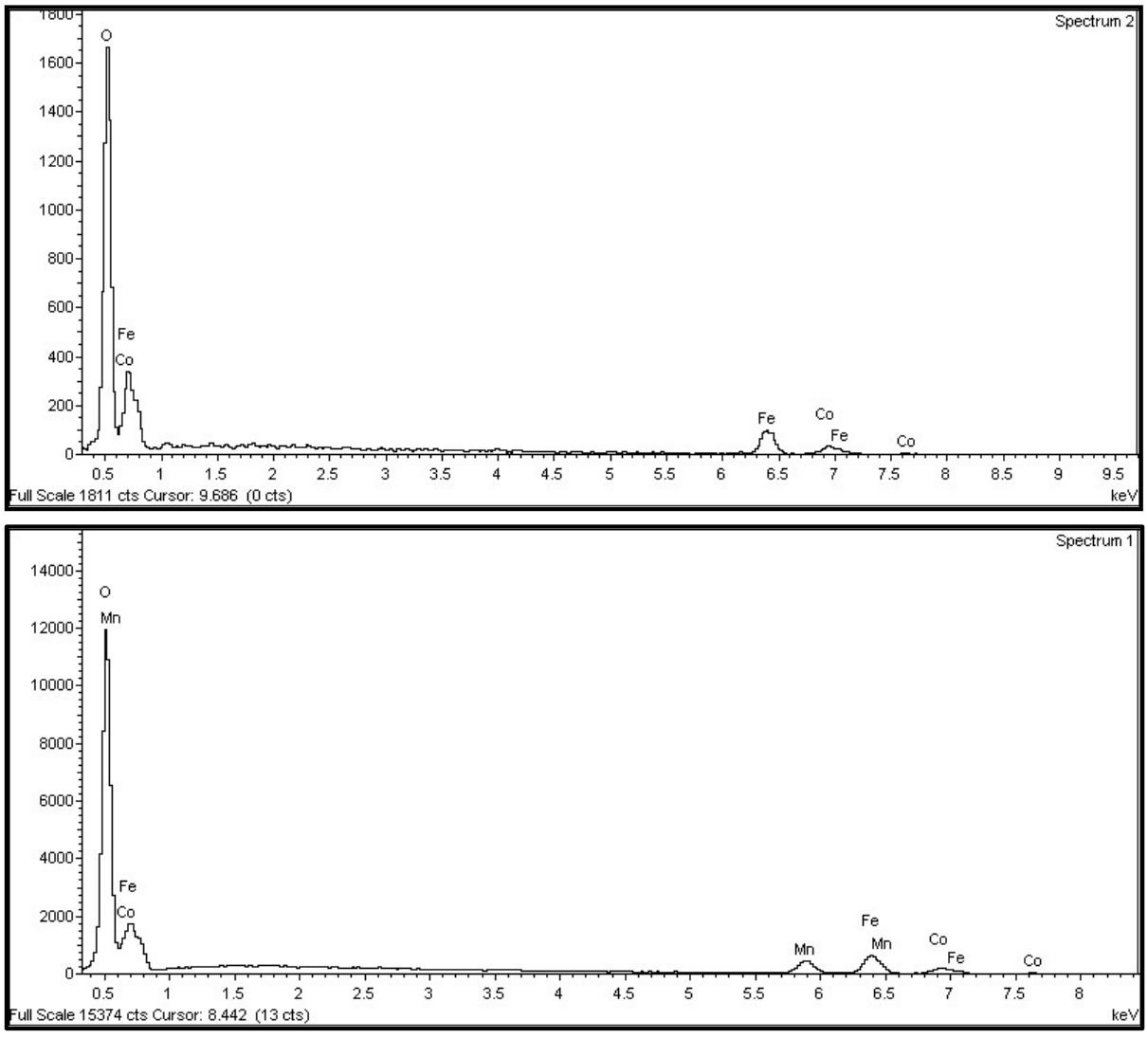

Figure S8: EDS spectra of the (a) pure cobalt ferrite and (b) $Co_{0.4}Mn_{0.6}Fe_2O_4$ sample composition.