Supporting Information

Manifestation of Dissimilar Types of Magnetism in Iron and Chromium Substituted Mn_2SnS_4

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Table S1: Weight of the elements used for synthesis of Fe substituted Mn_2SnS_4 compounds.

Fe content (%)	Weight of the elements			
	Weight of Mn (g)	Weight of Fe (g)	Weight of Sn (g)	Weight of S (g)
3	0.0886	0.0028	0.0987	0.1099
6	0.0859	0.0056	0.0987	0.1099
9	0.0831	0.0084	0.0987	0.1098

Table S2: Weight of the elements used for synthesis of Cr substituted Mn_2SnS_4 compounds.

Cr content (%)	Weight of the elements			
	Weight of Mn (g)	Weight of Cr (g)	Weight of Sn (g)	Weight of S (g)
4	0.0878	0.0035	0.0988	0.1100
8	0.0842	0.0069	0.0989	0.1100
10	0.0824	0.0087	0.0989	0.1100
15	0.0779	0.0130	0.0990	0.1101

Table S3. PXRD Refinement Table for Fe and Cr substituted compounds

Fe content	**3%**	**6%**	**9%**
a (Å)	7.4191(9)	7.3935(9)	7.4110(7)
b (Å)	10.474(1)	10.464(1)	10.473(1)
c (Å)	3.6640(5)	3.6598(5)	3.6631(4)
χ^2	1.07	1.07	1.01
Rp	7.35	7.30	6.83
Rwp	9.61	9.27	8.75
Rexp	9.26	8.96	8.73

Cr content	**4%**	**8%**	**10%**	**15%**
a (Å)	7.400(2)	7.417(1)	7.326(1)	7.398(1)
b (Å)	10.461(2)	10.474(2)	10.426(2)	10.467(2)
c (Å)	3.6674(9)	3.6642(6)	3.6691(7)	3.6595(6)
χ^2	1.08	1.04	1.52	1.19
Rp	7.06	6.17	6.29	7.08
Rwp	9.15	7.97	8.37	9.02
Rexp	8.79	7.83	6.78	8.27

Table S4. Curie constant, Weiss constant and experimental average effective magnetic moment of Fe and Cr substituted compounds calculated from inverse susceptibility plot along with theoretical effective magnetic moment per magnetic ion.

Compound Formula	**Weiss constant (θ) K**	**Curie constant (C)**	**Average effective magnetic moment (μ_B) per magnetic ion**	**Theoretical effective magnetic moment (μ_B) per magnetic ion**
$Mn_{1.94}Fe_{0.06}SnS_4$	-445	10.42	6.46	5.92
$Mn_{1.88}Fe_{0.12}SnS_4$	-478	8.50	5.83	5.92
$Mn_{1.82}Fe_{0.18}SnS_4$	-509	8.34	5.78	5.92
$Mn_{1.92}Cr_{0.08}SnS_4$	-552	11.22	6.70	5.85
$Mn_{1.84}Cr_{0.16}SnS_4$	-592	13.35	7.31	5.78
$Mn_{1.80}Cr_{0.20}SnS_4$	-589	10.67	6.53	5.75
$Mn_{1.70}Cr_{0.30}SnS_4$	-587	9.83	6.27	5.66

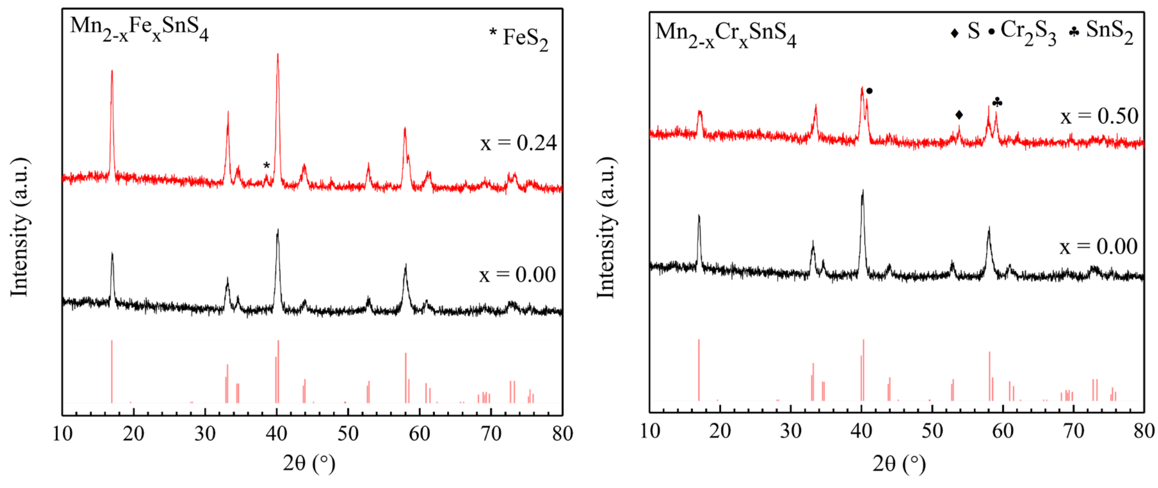
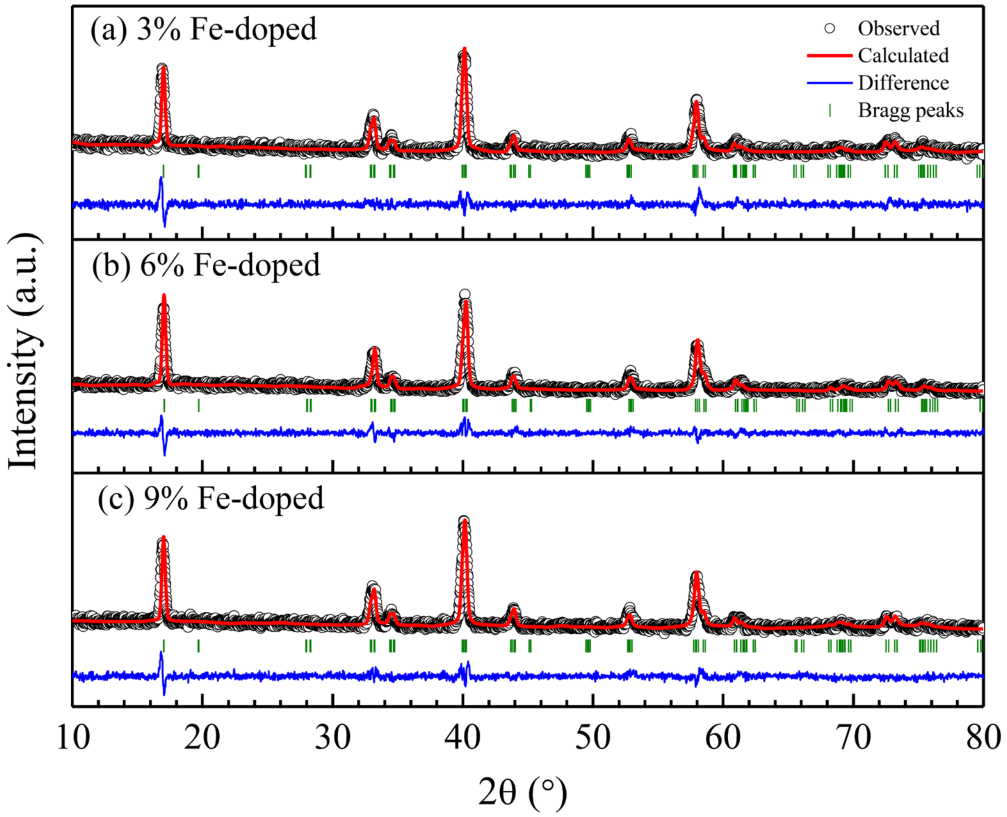


Figure S1: PXRD analysis of trial reaction of $Mn_{2-x}Fe_xSnS_4$ (x = 0.24) i.e., 12% Fe-doping and $Mn_{2-x}Cr_xSnS_4$ (x = 0.50) i.e., 25% Cr-doping. The reference pattern (Mn_2SnS_4) is 73-0829. Different symbols are used for denoting impurity phases.



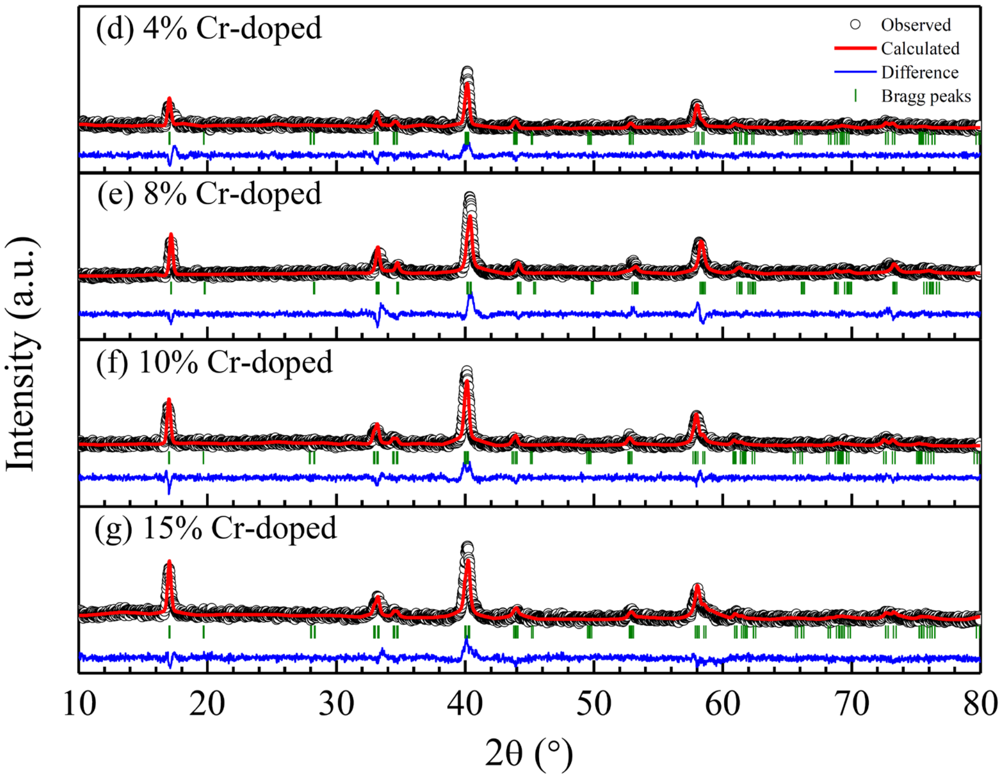


Figure S2. Rietveld refinement of powder X-ray diffraction data of (a) 3% Fe-doped Mn_2SnS_4, (b) 6% Fe-doped Mn_2SnS_4, (c) 9% Fe-doped Mn_2SnS_4, (d) 4% Cr-doped Mn_2SnS_4, (e) 8% Cr-doped Mn_2SnS_4, (f) 10% Cr-doped Mn_2SnS_4, and (g) 15% Cr-doped Mn_2SnS_4.

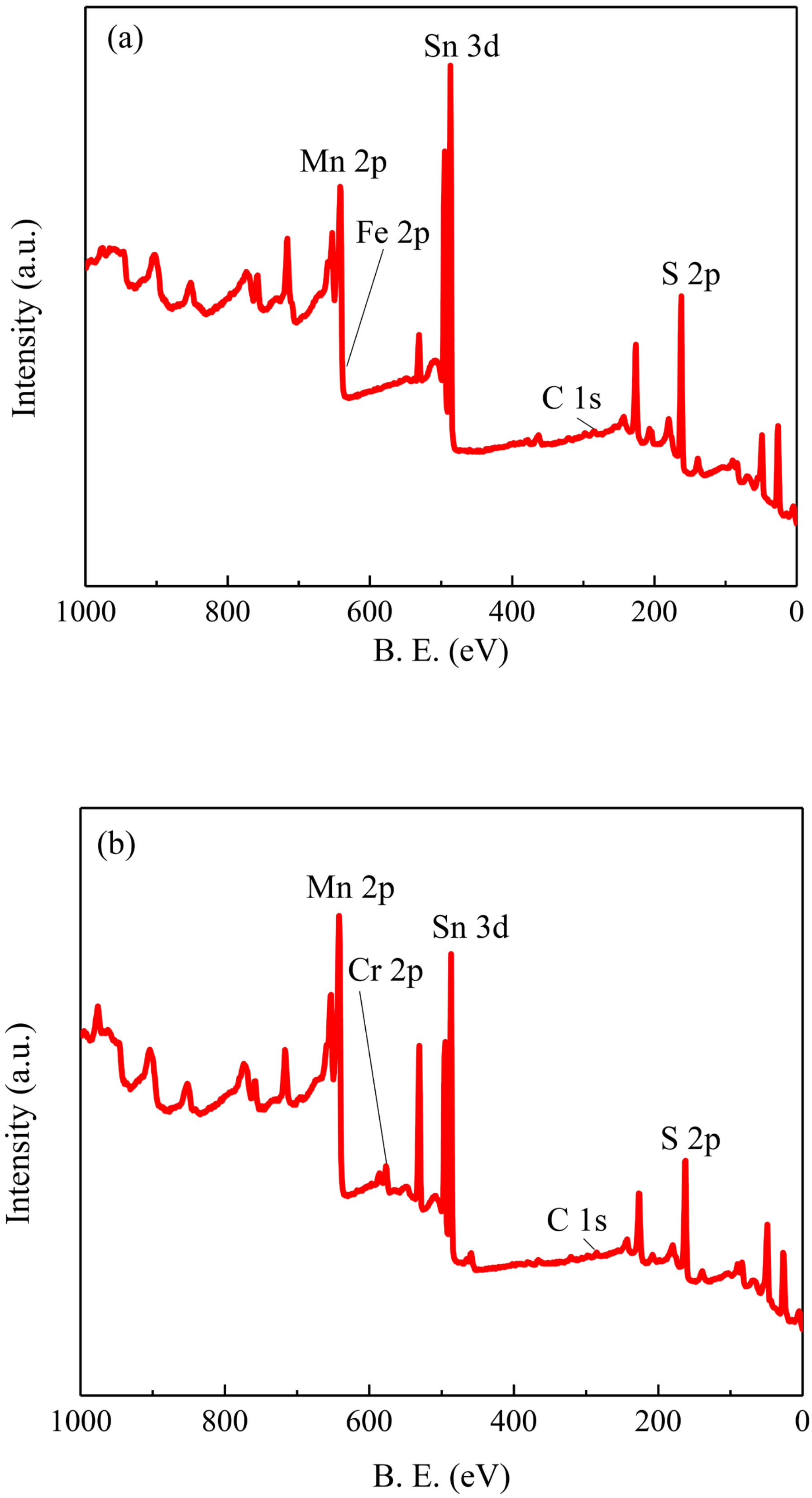


Figure S3. XPS survey scans (a) $Mn_{1.82}Fe_{0.18}SnS_4$ and (b) $Mn_{1.80}Cr_{0.20}SnS_4$

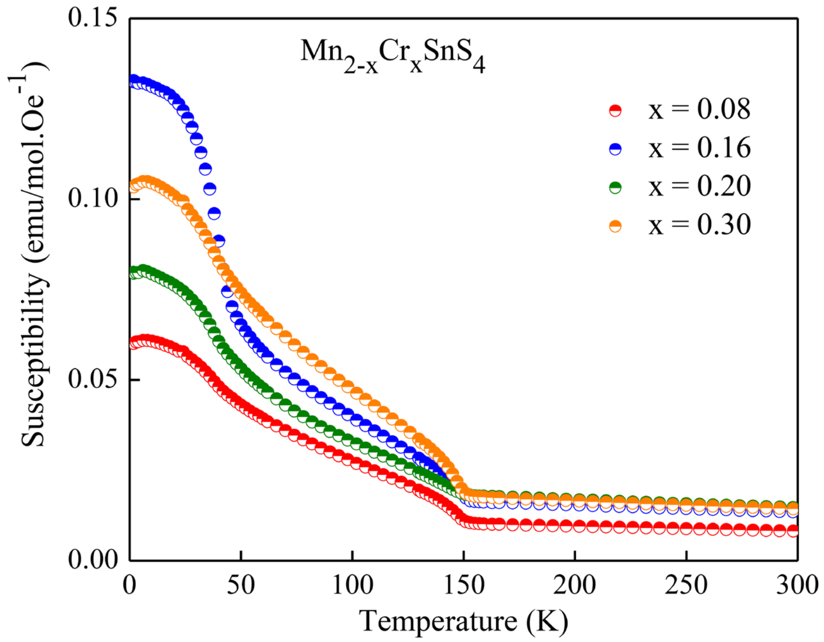


Figure S4. Molar susceptibility vs temperature plot of $Mn_{2-x}Cr_xSnS_4$ (x = 0.08, 0.16, 0.20 and 0.30) at 5000 Oe.

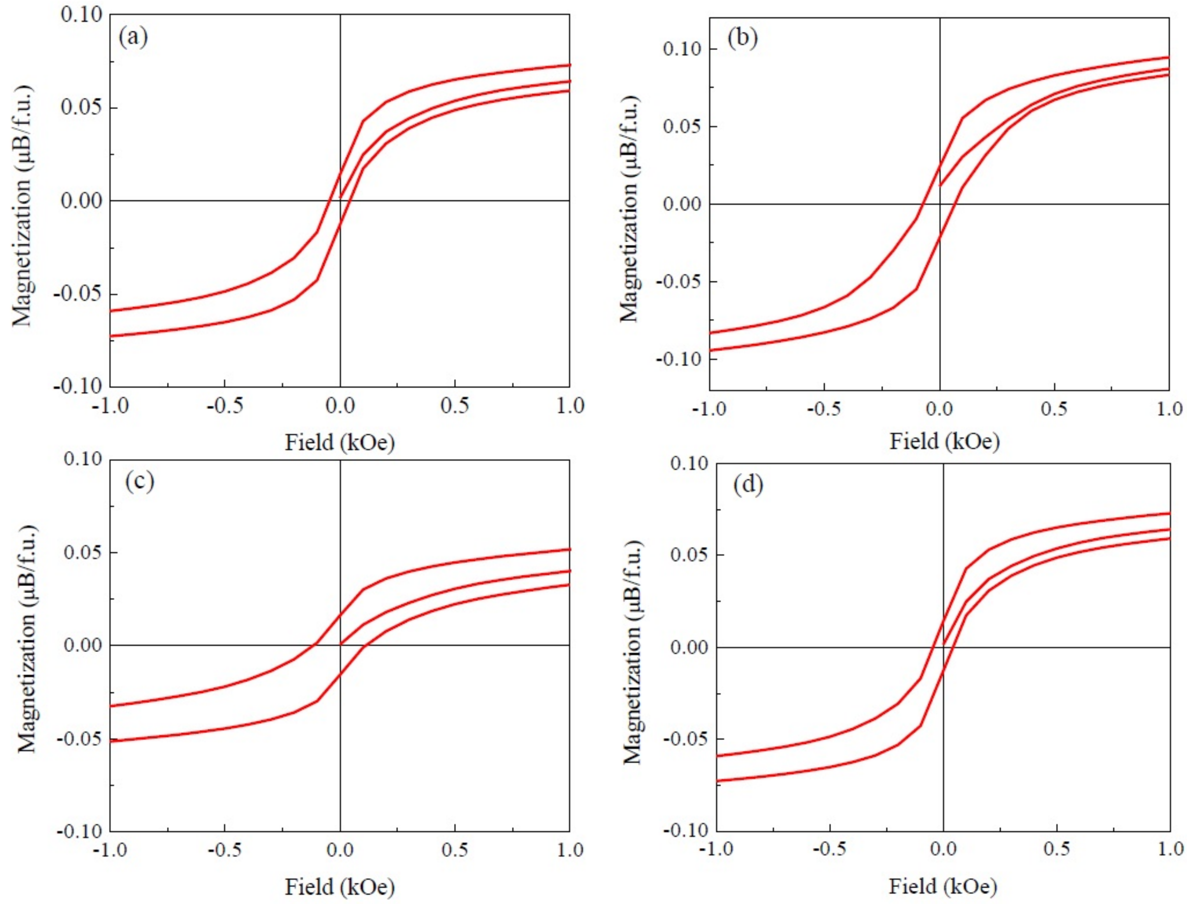


Figure S5. Hysteresis loop in isothermal magnetization (M) versus applied magnetic field (H) data of $Mn_{2-x}Cr_xSnS_4$ at 5 K (a) for x = 0.08, (b) x = 0.16 and (c) for x = 0.20 and (d) for x = 0.30.

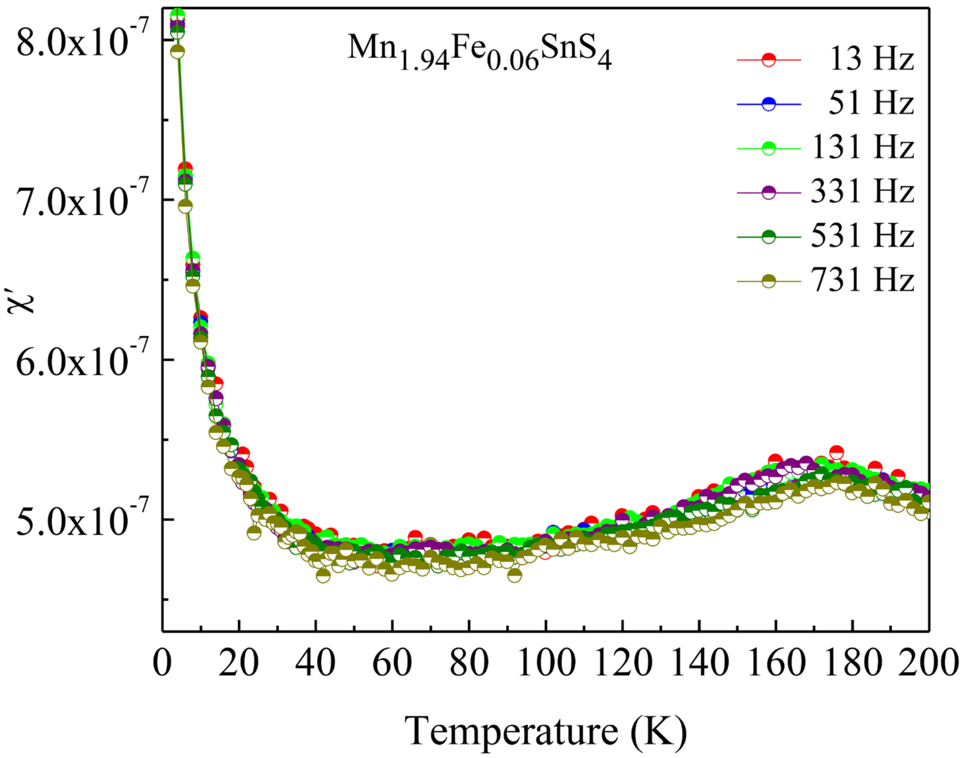


Figure S6. AC susceptibility (Real part) plot of $Mn_{1.94}Fe_{0.06}SnS_4$ measured at different frequencies.