Supporting information

Structure and Magnetism of Iron-Substituted Nickel Hydroxide Nanosheets

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Table S1. Mass and volume of chemical precursors used for the microwave synthesis of $Ni(OH)_2$ and Fe-substituted $Ni(OH)_2$ nanosheets.

Precursor	**$Ni_{1-x}Fe_x$ ratio**				
	$Ni_{1.00}Fe_{0.00}$	**$Ni_{0.95}Fe_{0.05}$**	**$Ni_{0.90}Fe_{0.10}$**	**$Ni_{0.80}Fe_{0.20}$**	**$Ni_{0.50}Fe_{0.50}$**
$Ni(NO)_2 \cdot 6\ H_2O$ (g)	1.00	0.95	0.90	0.80	0.50
$FeSO_4 \bullet 7\ H_2O$ (g)	0.00	0.478	0.956	0.1434	0.478
Urea (g)	0.82				
H_2O (mL)	3.0				
Ethylene glycol (mL)	21.0				

A pure solution of nickel nitrate, urea, ethylene glycol and water without any iron sulfate ($Ni_{1.00}Fe_{0.00}$) produces an opaque green solution before the microwave reaction. In contrast, a pure solution of iron sulfate, urea, ethylene glycol and water without any nickel nitrate ($Ni_{0.00}Fe_{1.00}$) produces an opaque yellow solution (Figure S1a). Substituting nickel nitrate for iron sulfate gradually changes the color of the pre-reaction solution from the characteristic green of a pure nickel nitrate solution to the yellow of a pure iron sulfate solution. After microwave heating, the colors of the reactants progressively darken from a light green ($Ni_{1.00}Fe_{0.00}$) to progressively darker shades of yellow ($Ni_{0.95}Fe_{0.05}$), orange ($Ni_{0.90}Fe_{0.10}$), light brown ($Ni_{0.80}Fe_{0.20}$), rust colored ($Ni_{0.50}Fe_{0.50}$) and dark brown ($Ni_{0.00}Fe_{1.00}$) with increasing iron content (Figure S1b); the color changes observed in the post-reaction solutions are also present during washing and centrifugation and after drying (Figure S1c-d).

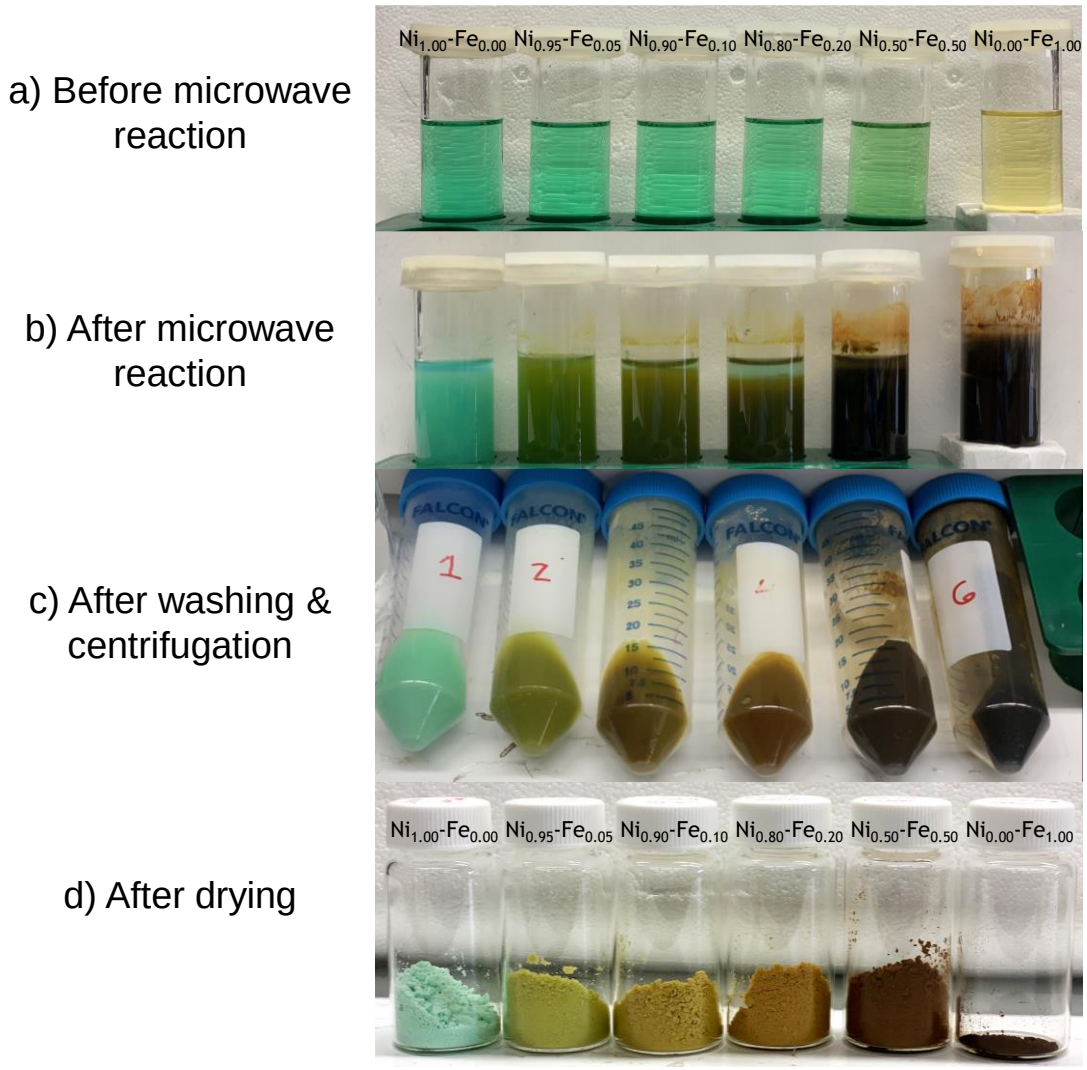

Figure S1. Photographs of the microwave synthesized iron-substituted nanosheet powders a) before microwave reaction, b) after the microwave reaction, c) after washing and centrifugation, and d) after drying.

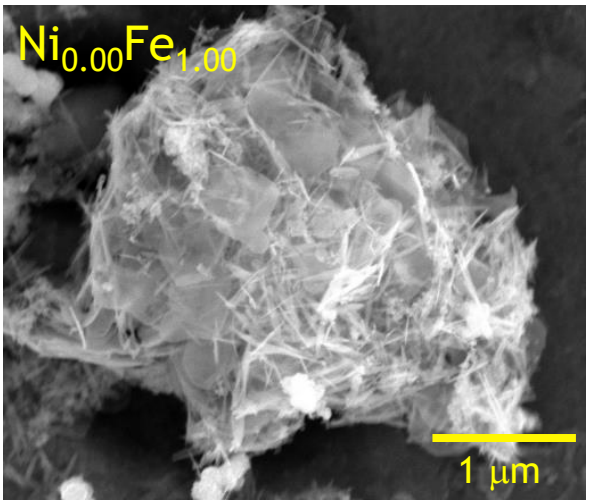

Figure S2. Scanning electron micrograph of $Ni_{0.00}Fe_{1.00}$.

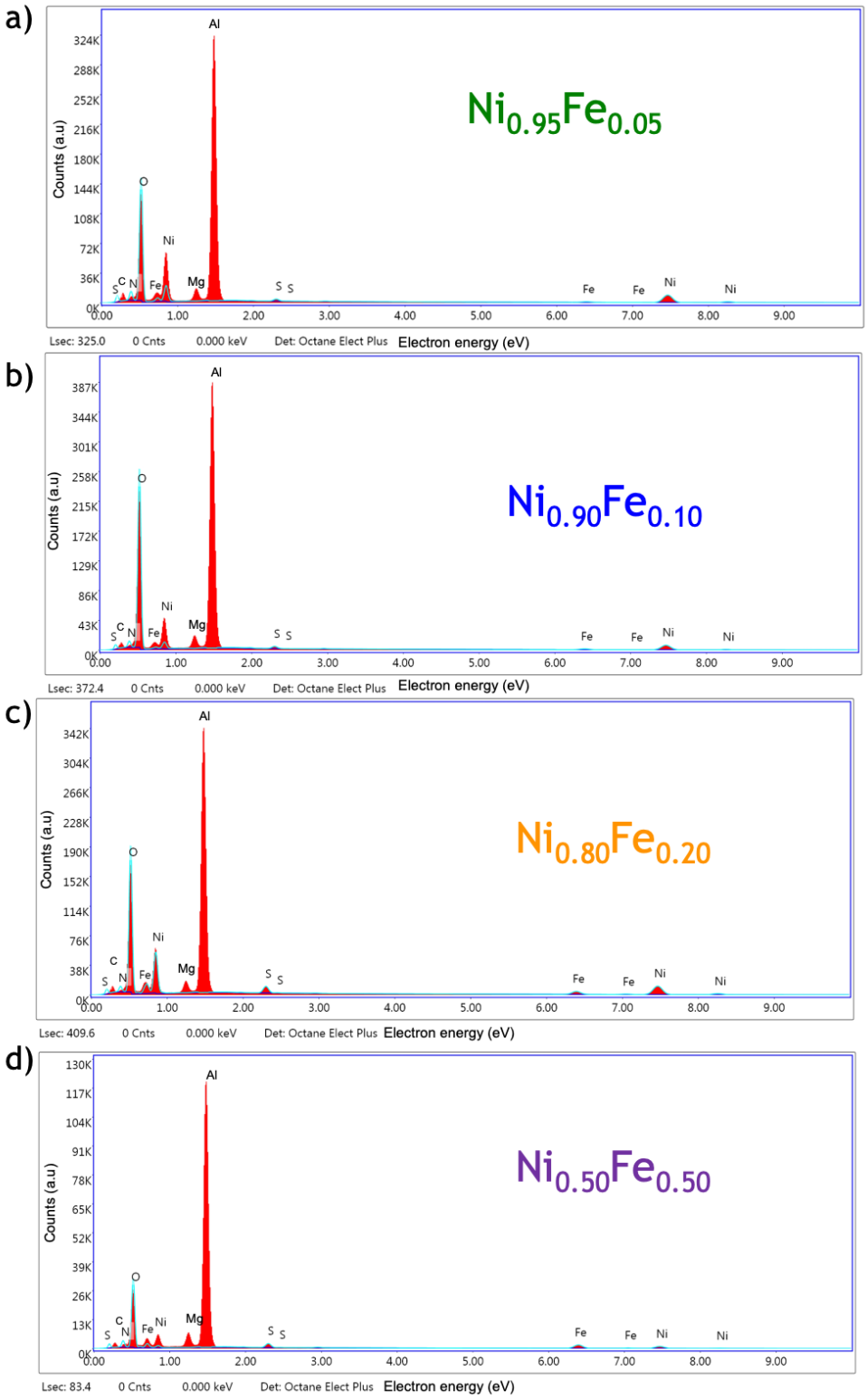

Figure S3. Energy dispersive X-ray spectra of a) $Ni_{0.95}Fe_{0.05}$, b) $Ni_{0.90}Fe_{0.010}$, c) $Ni_{0.80}Fe_{0.020}$, and d) $Ni_{0.50}Fe_{0.50}$.

Table S2. Average atomic % of elements determined by energy dispersive X-ray spectra.

	Ni	Fe	O	N	S
$Ni_{0.95}Fe_{0.05}$	17.87 ± 0.74	1.12 ± 0.11	66.51 ± 4.06	9.98 ± 0.05	0.91 ± 0.15
$Ni_{0.90}Fe_{0.10}$	12.92 ± 5.44	2.08 ± 1.40	76.78 ± 7.78	6.02 ± 0.84	1.66 ± 1.19
$Ni_{0.80}Fe_{0.20}$	14.46 ± 3.18	3.62 ± 0.13	73.12 ± 3.45	6.39 ± 0.28	2.41 ± 0.13
$Ni_{0.50}Fe_{0.50}$	8.07 ± 0.05	8.43 ± 0.95	75.85 ± 0.66	5.20 ± 0.47	2.46 ± 1.13

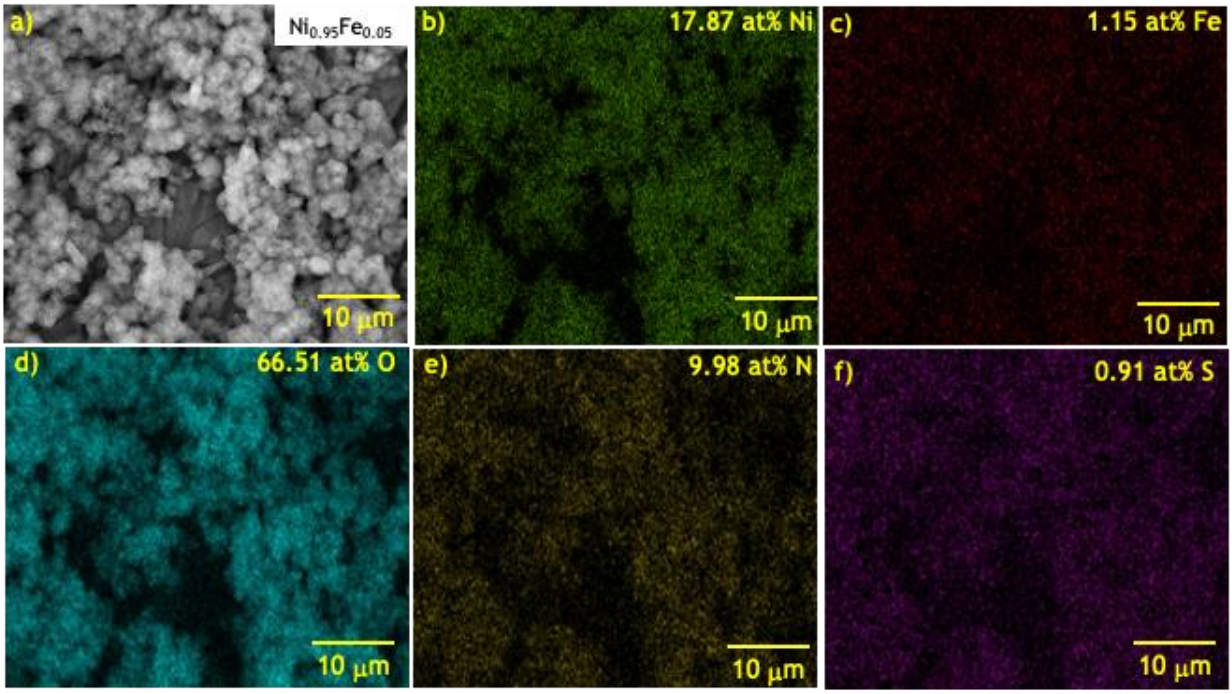

Figure S4. SEM image (a) and elemental mapping of Ni, Fe, O, N, and S (b-f) of 5% Fe-substituted $Ni(OH)_2$ nanosheets ($Ni_{0.95}Fe_{0.05}$).

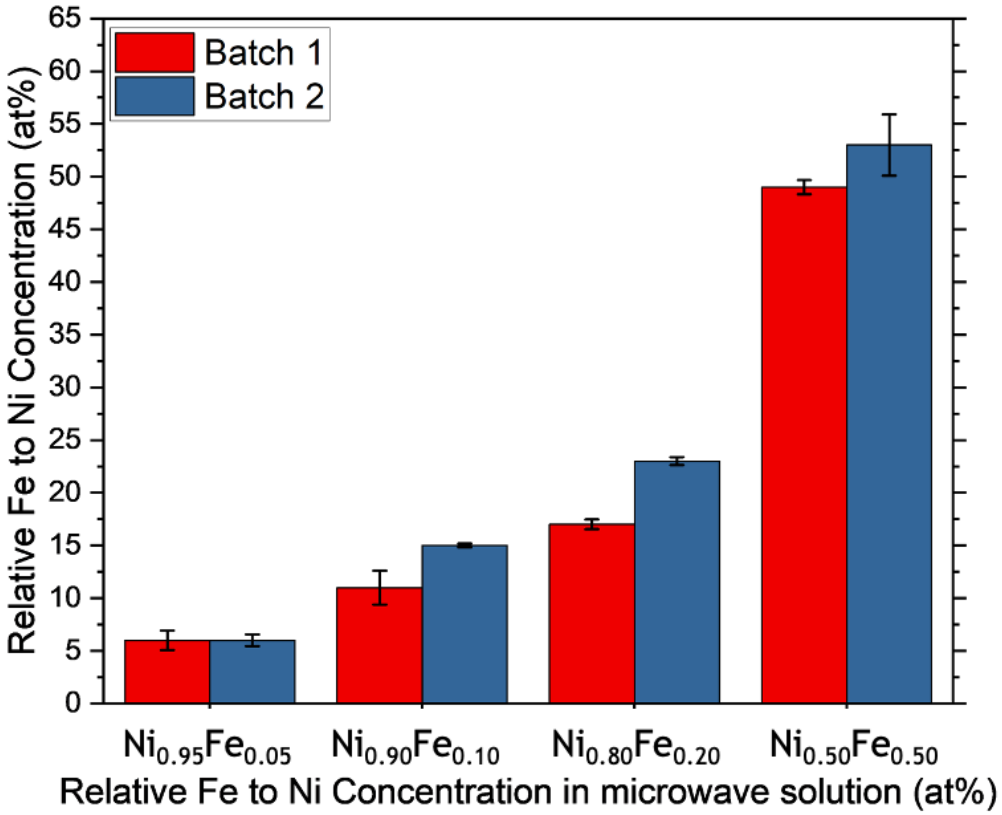

Figure S5. Comparison of the relative Fe-to-Ni concentration between two batches of material.

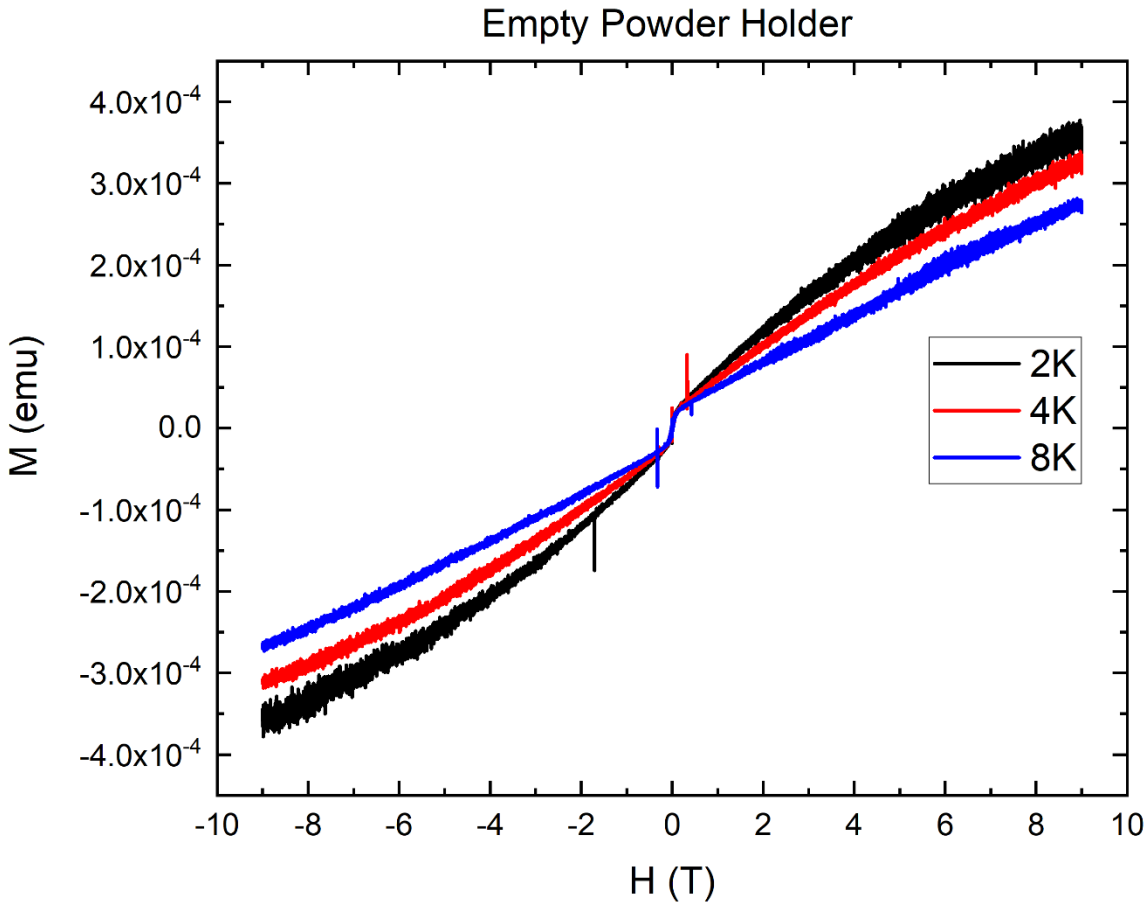

Figure S6. Magnetization versus magnetic field at 2 K, 4 K, and 8 K of an empty powder holder; the magnetization is two-three orders of magnitude smaller than the signal from the sample ensuring that the holder signal did not significantly contribute to the sample signal.

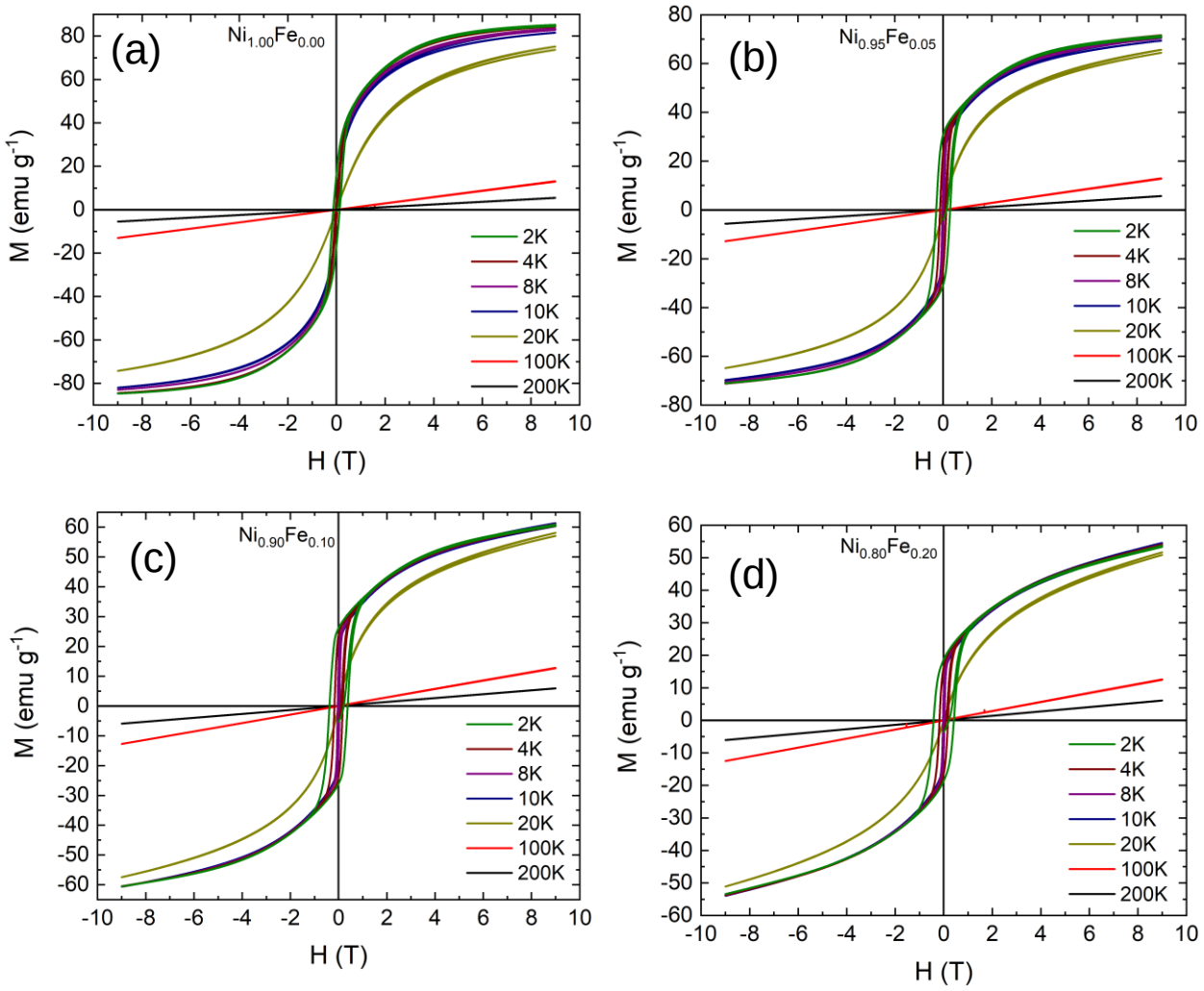

Figure S7. M vs H loops in the full range of the magnetic fields, +9 T to –9 T, at temperatures of 2-200 K for (a) $Ni_{1.00}Fe_{0.00}$ (0% Fe), (b) $Ni_{0.95}Fe_{0.05}$ (5% Fe), (c) $Ni_{0.90}Fe_{0.10}$ (10% Fe), and (d) $Ni_{0.80}Fe_{0.20}$ (20% Fe). One feature of the loops of the 10% and 20% Fe is the lack of saturation which points to the existence of noncollinear (canted) magnetic structure.

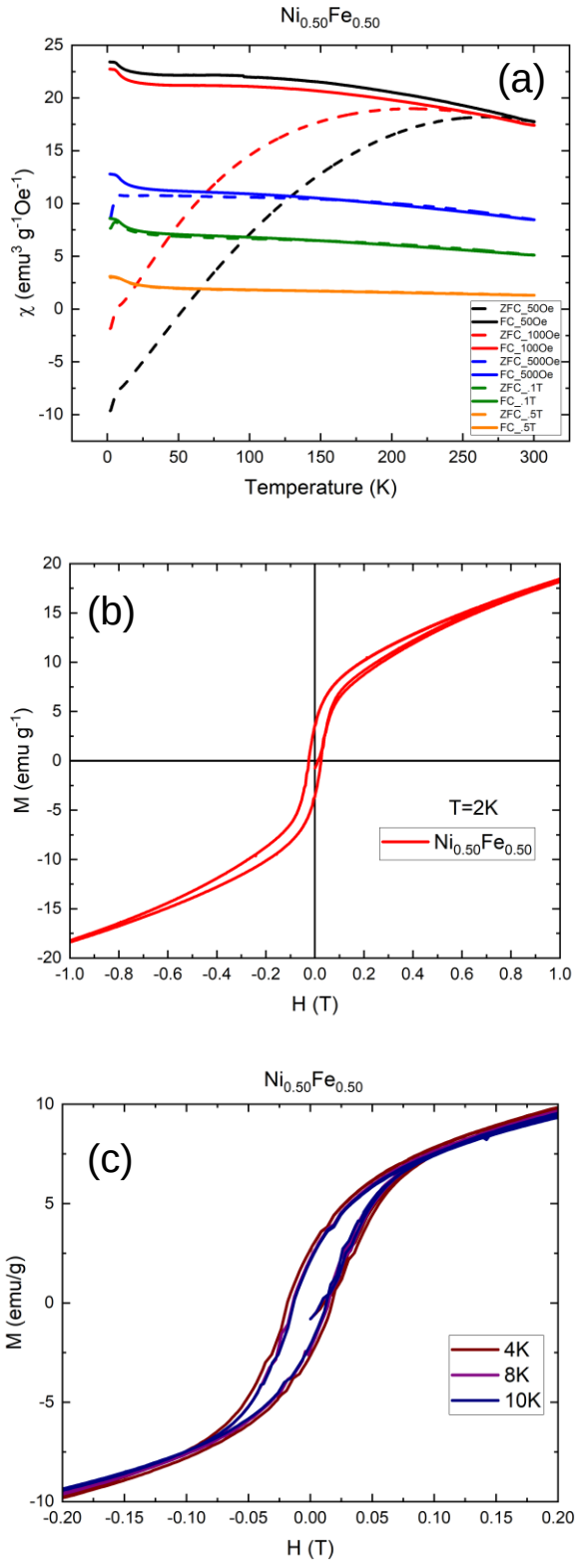

Figure S8. (a) FC and ZFC Magnetization, (b) M-H loop at 2 K, and (c)M-H loops at 4 K, 8 K, 10 K for 50 % Fe ($Ni_{0.50}Fe_{0.50}$).