Electronic Supplementary Material (ESI) for Environmental Science: Nano.

Supporting information

Investigation of magnetite-Co interactions: from environmentally relevant trace Co levels to core-shell Fe_3O_4@$Co(OH)_2$ nanoparticles with magnetic applications

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Table S1 *Corresponding total ($[Co]_{tot}$), aqueous ($[Co]_{aq}$) and solid ($[Co]_s$) concentrations of cobalt. *Samples analyzed by XAS and XMCD.*

$[Co]_{tot}$ (mM)	$[Co]_{aq}$ (mM)	$[Co]_s$ (mM)	$[Co]_s$ (atom nm^{-2})
0.003	0.000002	0.003	0.04
0.005	0.000003	0.005	0.06
0.01*	0.000006	0.010	0.12
0.02	0.000054	0.020	0.24
0.04 *	0.000286	0.040	0.48
0.1 *	0.001213	0.099	1.19
0.16	0.001895	0.158	1.90
0.2 *	0.015321	0.185	2.22
0.32	0.017277	0.303	3.65
0.64	0.051845	0.588	7.08
0.8 *	0.110548	0.689	8.30
1.28	0.366694	0.913	11.00
2.56	0.740426	1.820	21.92
3.00 *	0.863300	2.137	25.74

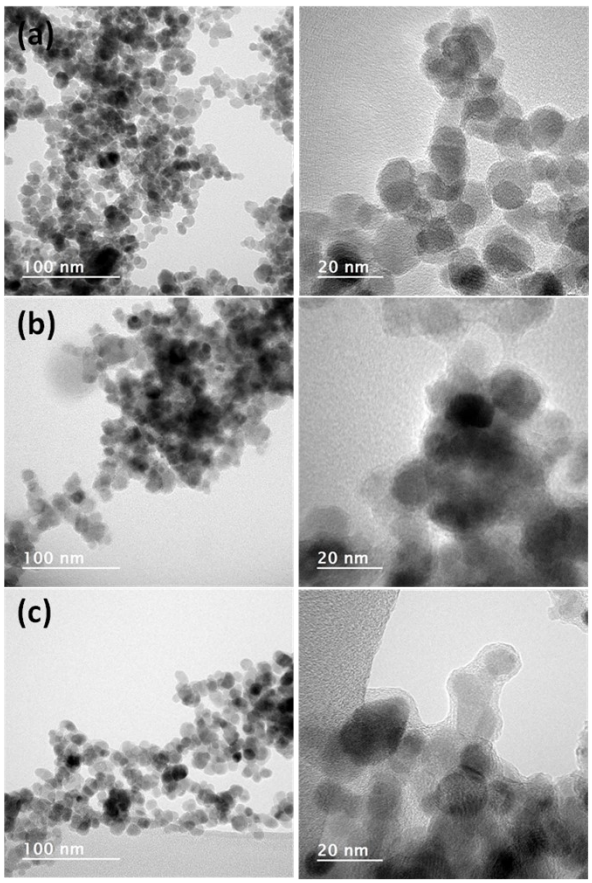
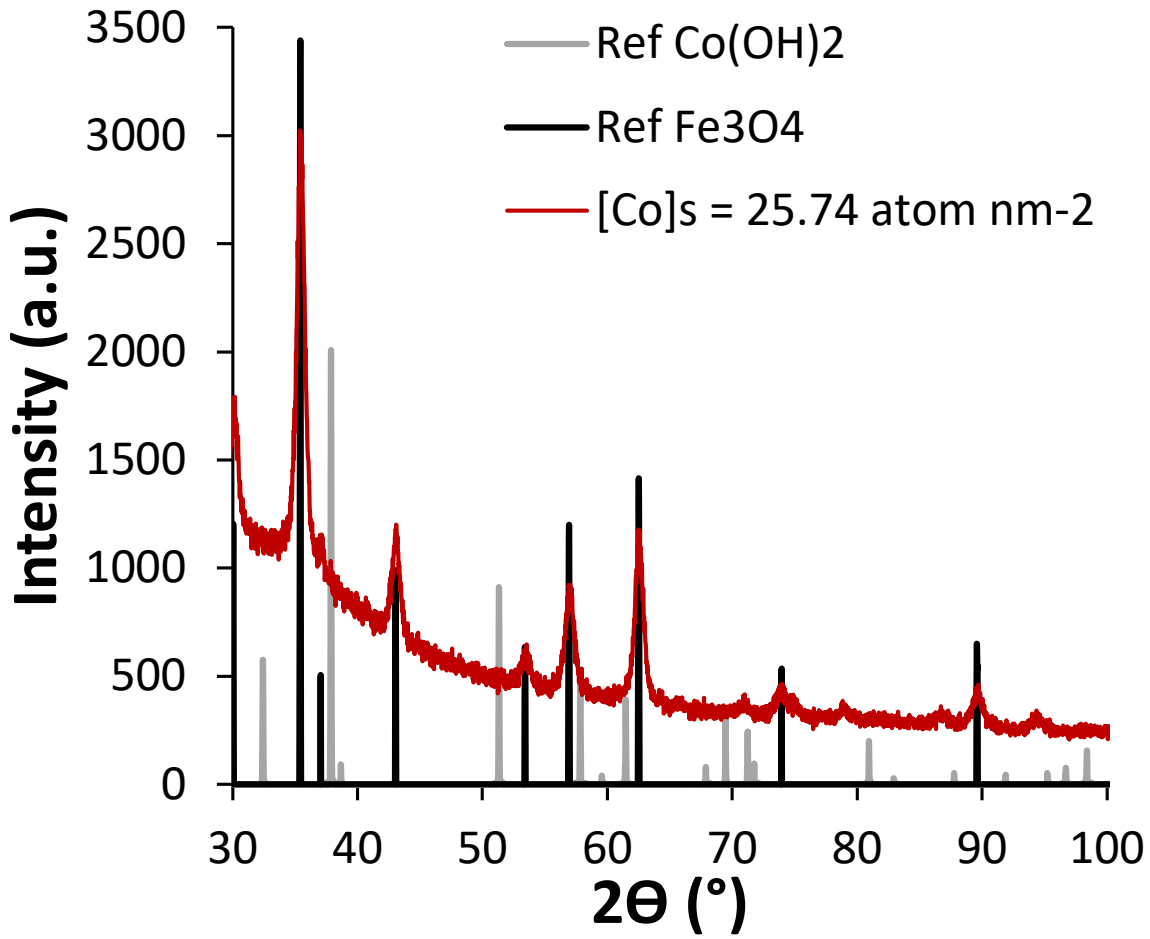


Fig. S1 *TEM images of stoichiometric magnetite nanoparticles with various Co concentrations: (a) $[Co]_s$ = 0.12 atom nm^{-2}, (b) $[Co]_s$ = 8.30 atom nm^{-2}, and (c) $[Co]_s$ = 25.74 atom nm^{-2}. The first image has a scale of 100 nm; the second of 20 nm.*



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ig. S2 *X-ray diffraction (XRD) pattern of the magnetite sample with* $[Co]_s$ *= 25.74 atom* nm^{-2} *(red line), and theoretical patterns of* $Co(OH)_{2(s)}$ *(grey line) and* Fe_3O_4 *(black line).*

Table S2 *Optimized parameters of equation 1, for Langmuir models (L_1 and L_2) and Freundlich model (F). Q_{max} is the adsorption capacities (atom nm^{-2}).*

	L_1	L_2	F
Q	0.45 ± 0.13	10.09 ± 1.70	
Log K	4.68 ± 0.17	1.41 ± 0.36	1.37 ± 0.26
n			2.34 ± 0.58

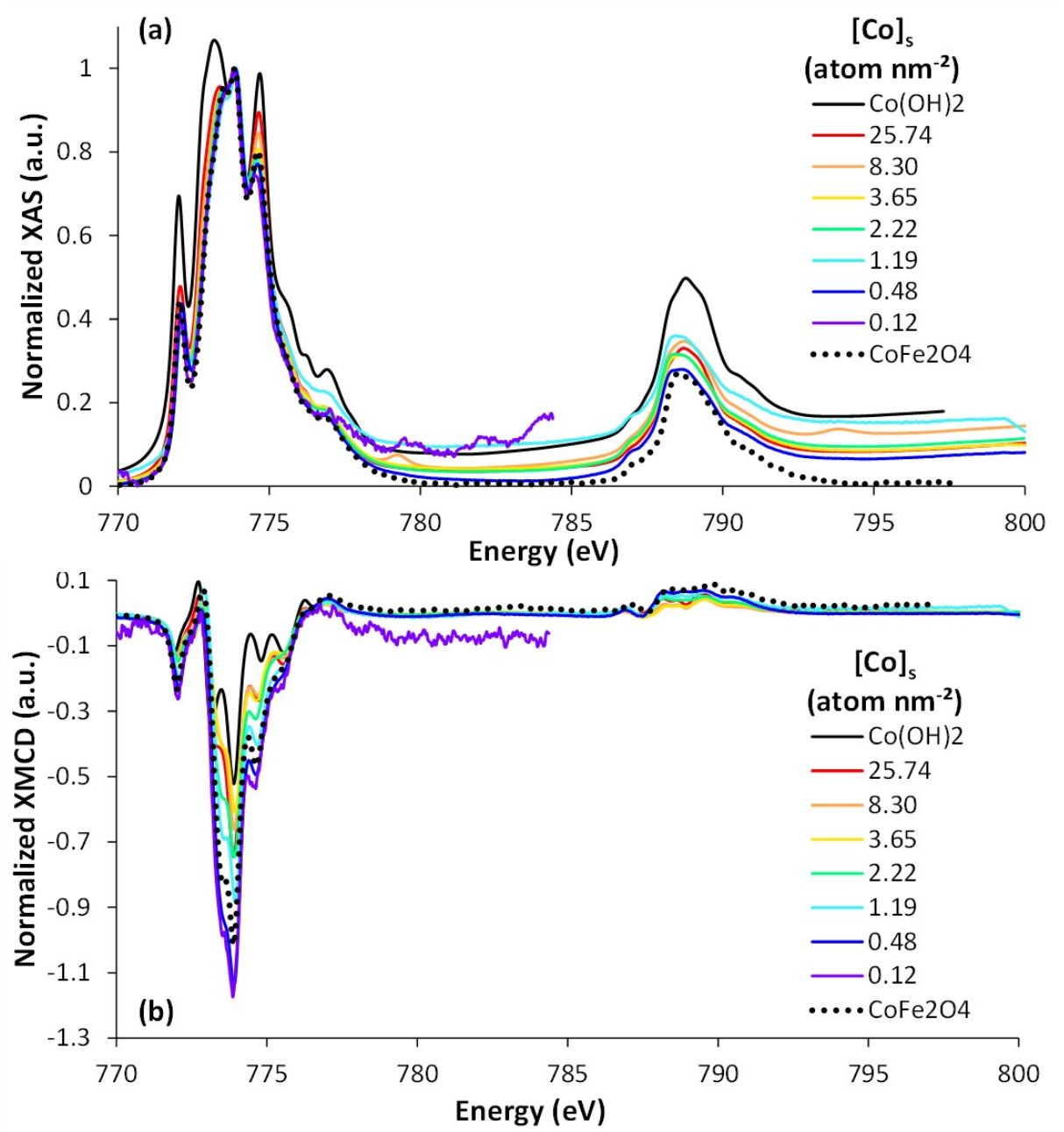

Fig. S3 *Normalized XAS (a) and XMCD (b) spectra at the $L_{2,3}$ cobalt edge of stoichiometric magnetite with different $[Co]_s$ (from 0.12 to 25.74 atom nm^{-2}). XMCD and XAS signals are normalized by dividing the raw signal by the edge jump of XAS.*

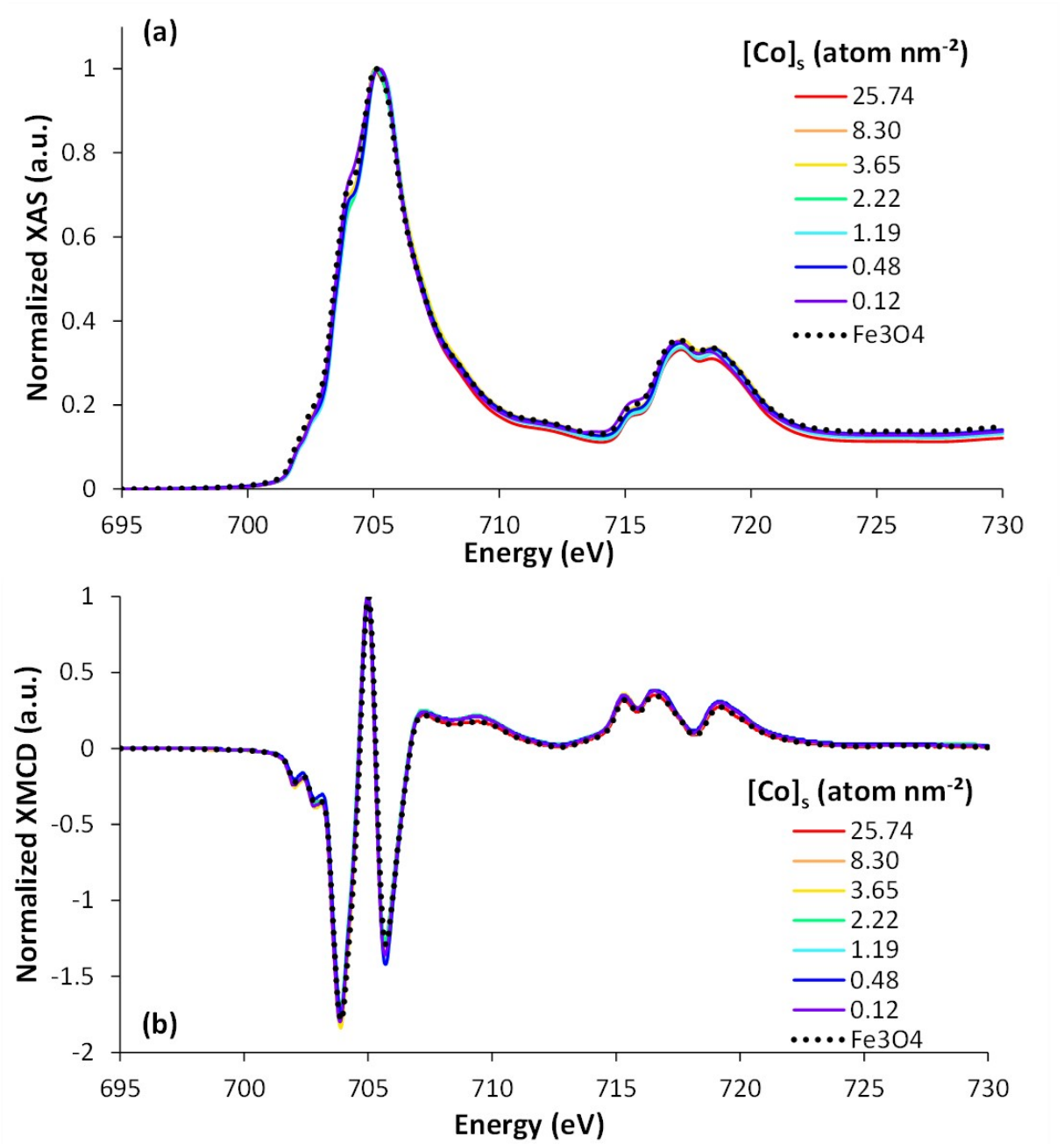

Fig. S4 *Normalized XAS (a) and XMCD (b) spectra at the Fe L_{2-3}-edge of stoichiometric magnetite with different $[Co]_s$ (from 0.12 to 25.74 atom nm^{-2}). XAS signals are normalized by dividing the raw signal by the edge jump of XAS. XMCD signal was normalized to the $Fe^{3+}{}_{(Td)}$ peak (positive one).*

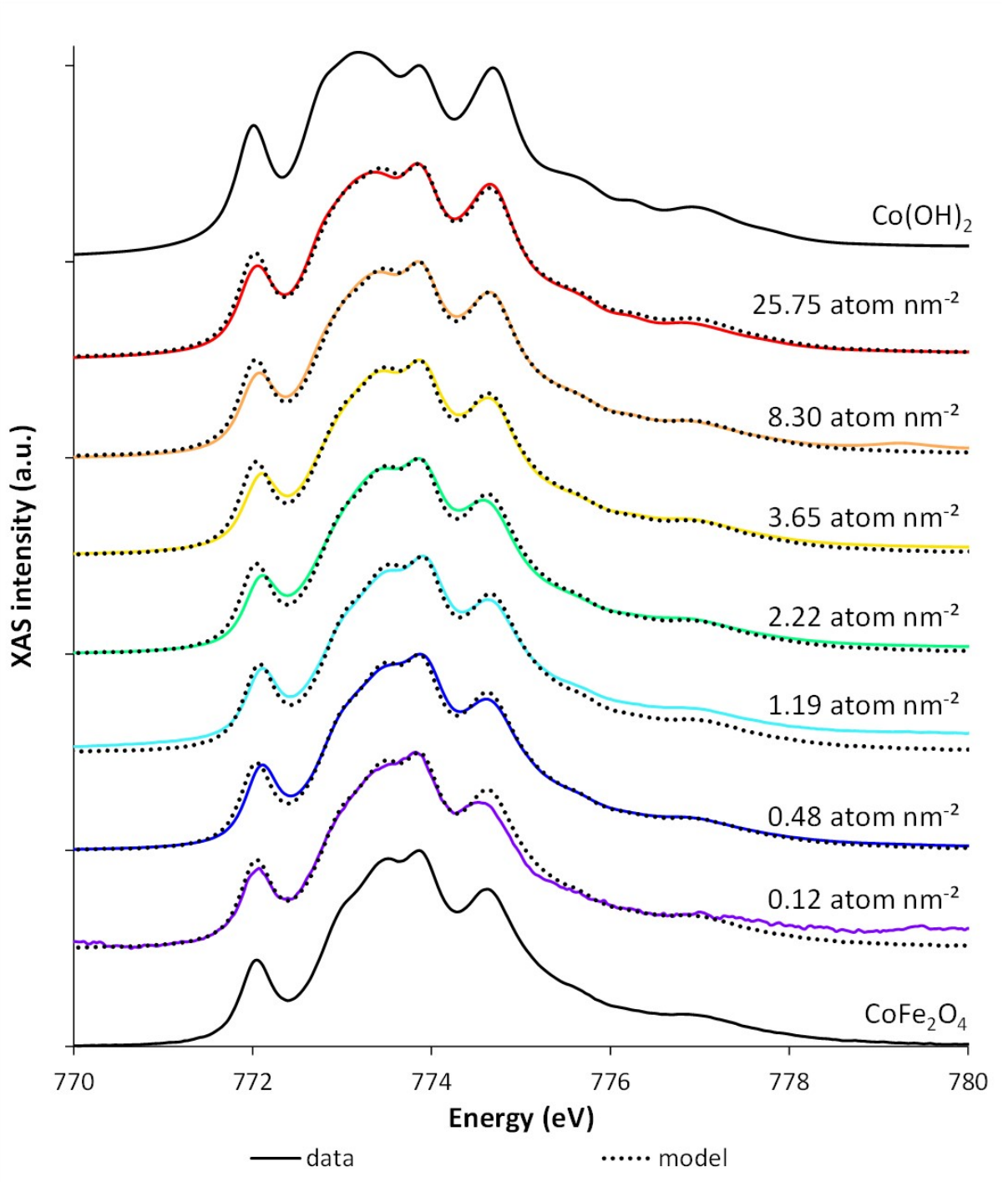

Fig. S5 *Linear combination analysis of normalized XAS spectra at Co L_3 edge for different $[Co]_s$ (from 0.12 to 25.74 atom nm^{-2}). Data are represented by a solid line and models by a dotted line.*

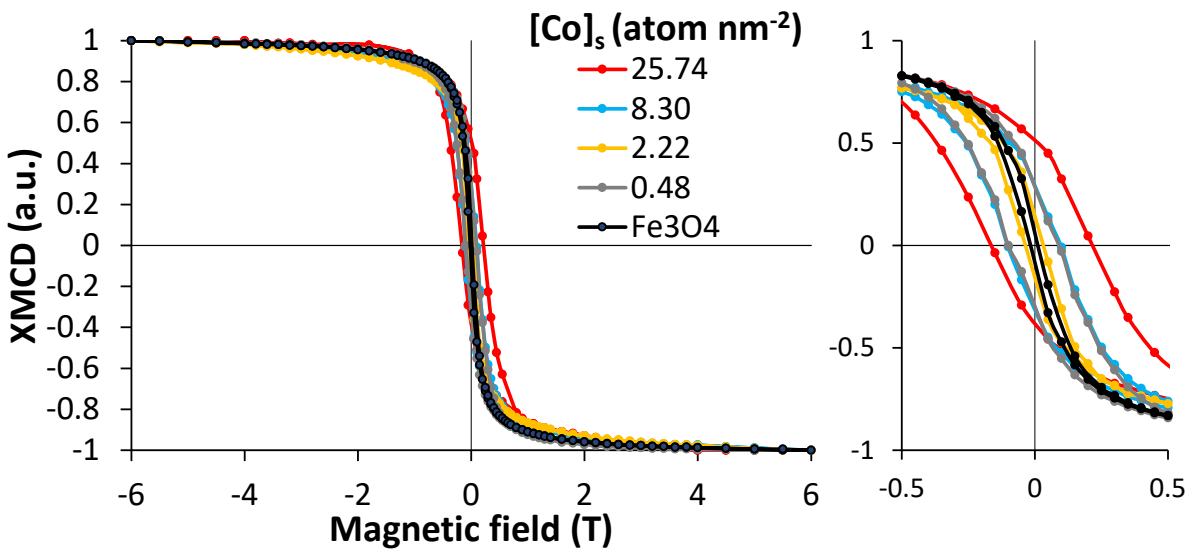

Fig. S6 *XMCD magnetization versus magnetic field measurement at Fe edge at 4.2 K for four $[Co]_s$ (from 0.48 to 25.74 atom nm^{-2}) and a sample of stoichiometric Fe_3O_4 without Co.*

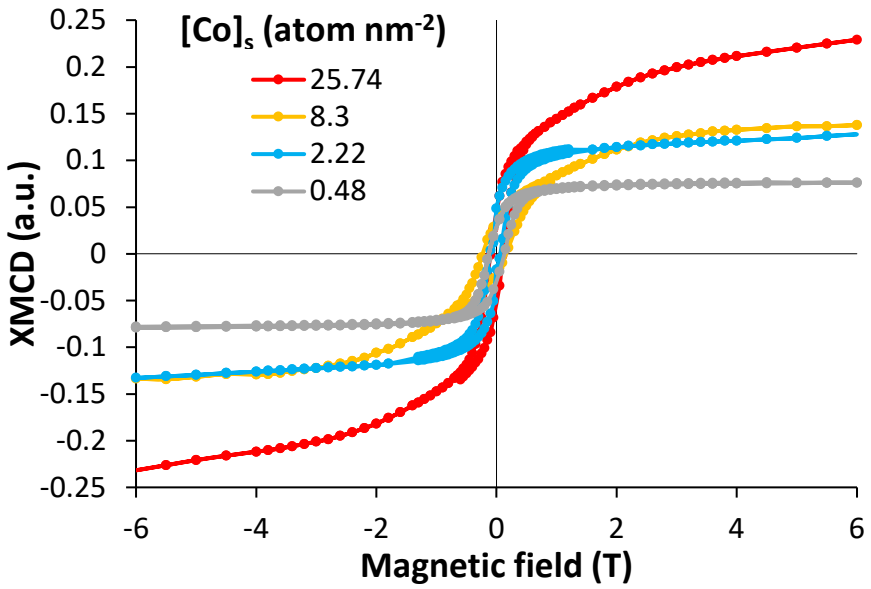

Fig. S7 *Raw XMCD magnetization curves versus magnetic field measurement at Co L_3-edge at 4.2 K for four solid cobalt concentrations (from 0.48 to 25.74 atom nm^{-2}).*