Structural, Magnetic and Catalytic Evaluation of Spinel Co, Ni, and Co-Ni Ferrite Nanoparticles Fabricated by Low-temperature Solution Combustion Process

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Supporting Information

Empirical compositions of the samples determined by the EDS technique

The empirical compositions of three samples determined by EDS technique (see Figure 4 in the main text) was as follows:

$CoFe_2O_4$-6:	$CoFe_{1.99}O_{5.01}$ (EDS results)
$NiFe_2O_4$-6:	$NiFe_{1.99}O_{4.37}$ (EDS results)
$Co_{0.5}Ni_{0.5}Fe_2O_4$-6:	$Co_{0.50}Ni_{0.54}Fe_{1.93}O_{6.25}$ (EDS results)

It can be observed that the Co/Fe and Ni/Fe ratios in the latter two samples are close to their expected values. However, the amount of oxygen is higher than expected because of the contribution of the following sources: (i) atmospheric H_2O adsorbed in the mesopores of the ferrites, (ii) OH groups at the surface of the ferrites, (iii) carboxylate groups ($-COO^-$) at the surface or coming from adventitious organic species. In fact, quantification of elements of lower atomic weights such as oxygen through EDS usually incorporate uncertainty in their estimated values due to reabsorption of the emitted X-ray, emission from contamination, and others as has been described by Goldstein et al.[s1]

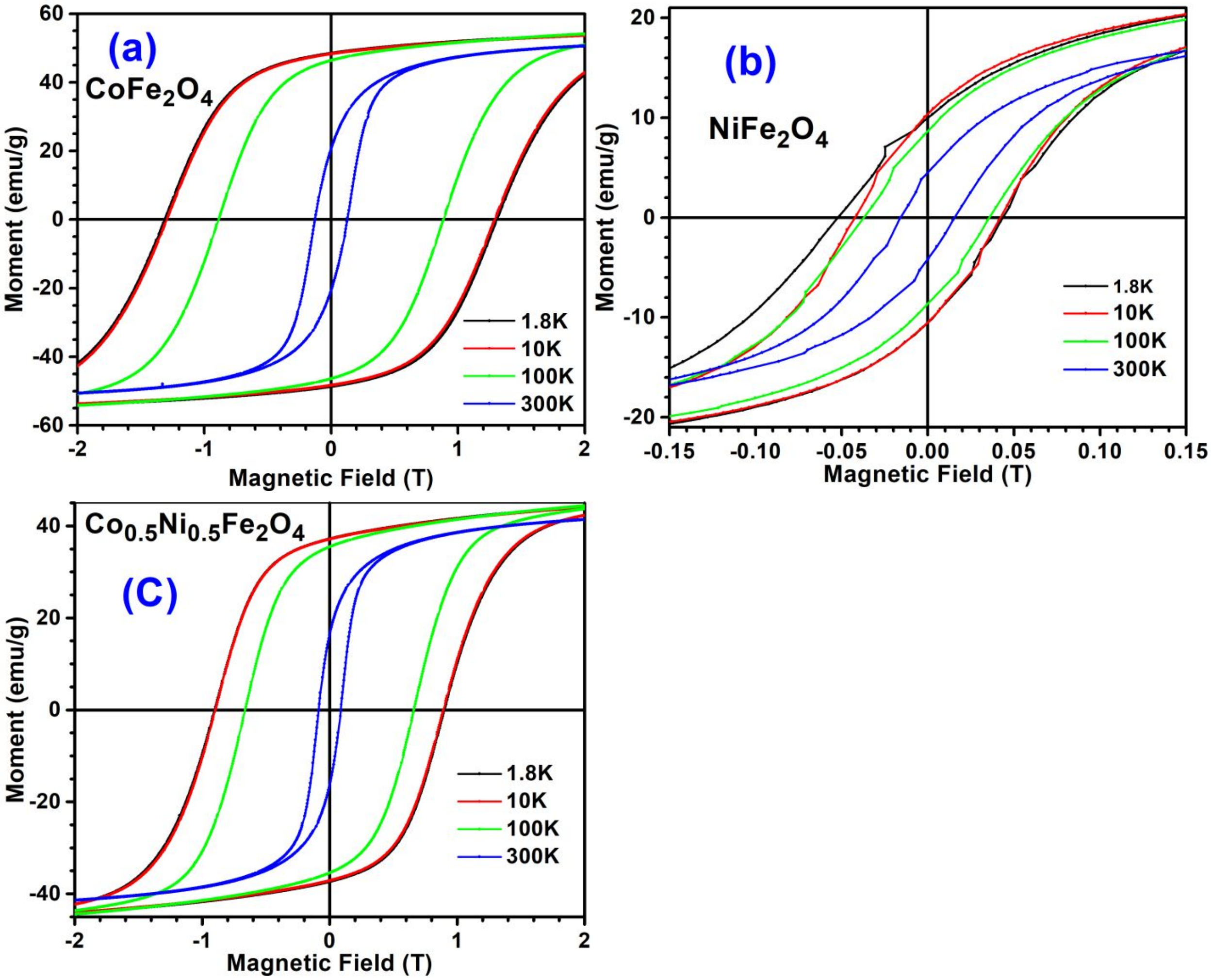

Figure S1. Hysteresis loops for (a) $CoFe_2O_4$, (b) $NiFe_2O_4$, and (c) $Co_{0.5}Ni_{0.5}Fe_2O_4$ ferrites showing the coercive field for each temperature.

Selected XPS lines for the $CoFe_2O_4$, $NiFe_2O_4$, and $Co_{0.5}Ni_{0.5}Fe_2O_4$ ferrites

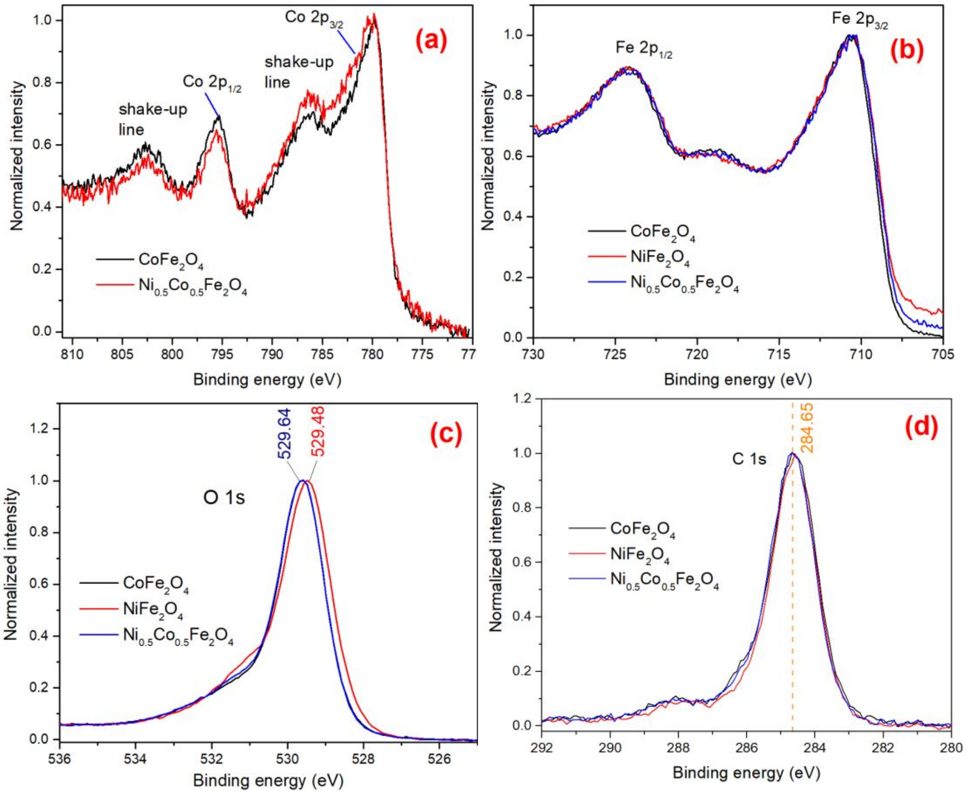

Figure S2. Comparison of the position and shape of four XPS lines for the $CoFe_2O_4$, $NiFe_2O_4$, and $Co_{0.5}Ni_{0.5}Fe_2O_4$ ferrites: (a) Co $2p_{3/2}$ and Co $2p_{1/2}$, (b) Fe $2p_{3/2}$ and Fe $2p_{1/2}$, (c) O 1s, and (d) C 1s.

Experimental procedure for reduction of 4-nitrophenol (4-NP) to 4-aminophenol

In a typical experiment, 4.0×10^{-5} moles (5.56 mg) of 4-NP were dissolved in 200 mL of deionized water to obtain a solution with a concentration of 0.2mM. Then, 4 mL of this solution were mixed with 12 mL deionized water in a 35 mL vial. Then, 15 mg of $NaBH_4$ was added to the solution and a UV-vis spectrum was recorded. After that, 10 mg of the $NiFe_2O_4$-3 sample was added to the solution and shaken. 10, 20, 30, 40, 50, 60, 80, 100, 120, 140, and 160 min after the catalyst was added, the NPs were separated with a magnet and an aliquot was transferred to a quartz cell to record the UV-vis spectrum. The reusability of this sample for the reduction of 4-NP was evaluated for 5 times; a spectrum was recorded at 3, 10, 15, 20, 30, 40, 50, and 60 min of reaction.

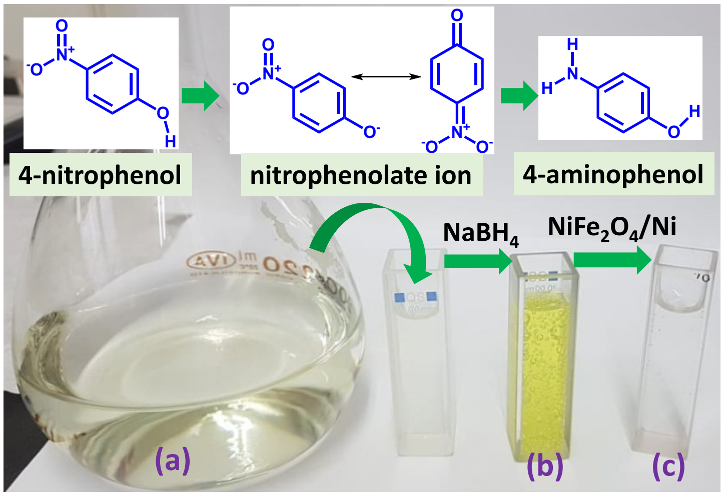

Figure S3. Colors of aqueous solutions of (a) 0.2 mM 4-nitrophenol, (b) nitrophenolate ion generated by the addition of NaBH$_4$ to the 4-NP solution, and (c) 4-aminophenol obtained after the reduction reaction in presence of the NiFe$_2$O$_4$-3 sample.

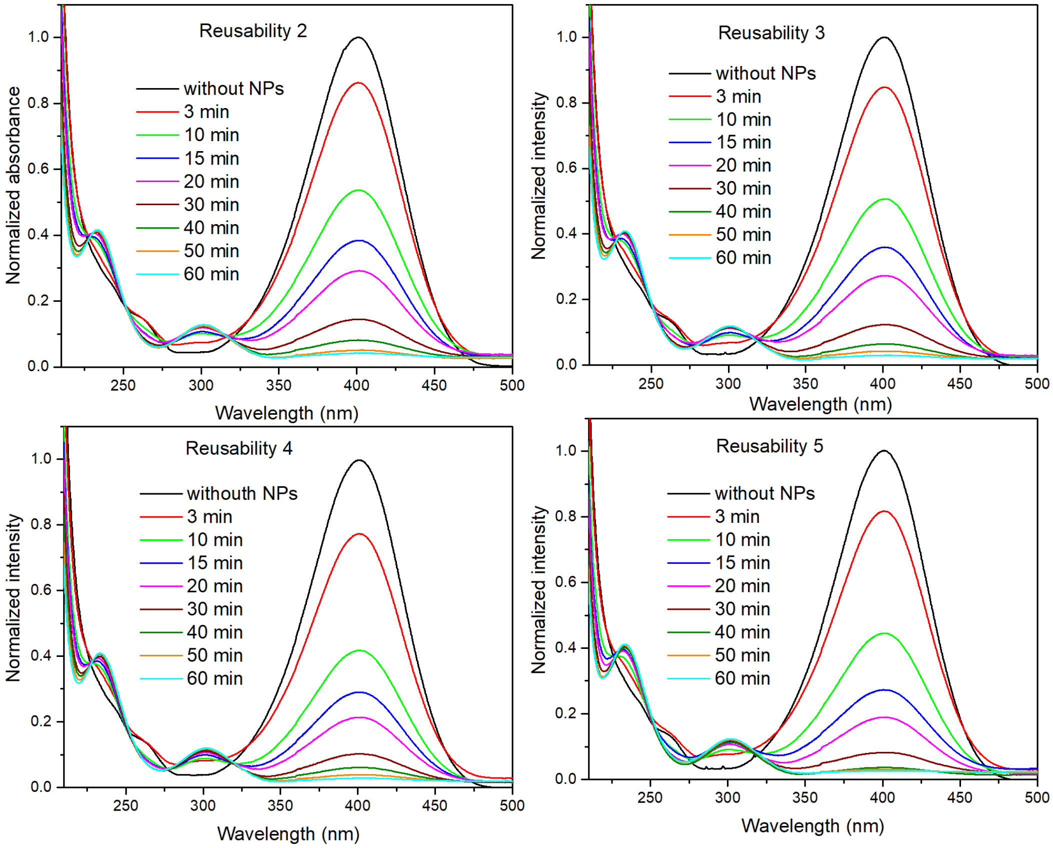

Figure S4. UV-vis spectrum of the reusability experiments of the NiFe$_2$O$_4$-3.0 sample for the reduction of 4-nitrophenol to 4-aminophenol. Note: the reusability 1 experiment was depicted in Figure 10b in the main text.

References

[1] Goldstein, J.; Newbury, D. E.; Joy, D. C.; Lyman, C. E.; Echlin, P.; Lifshin, E.; Sawyer, L. Michael, J.R. Scanning Electron Microscopy and X-Ray Microanalysis: 3rd ed. New York: Kluwer Academic/Plenum Publisher; pp 511, 527.