

Supporting Information

Observation of large low-field magnetoresistance in spinel cobaltite: A new half-metal

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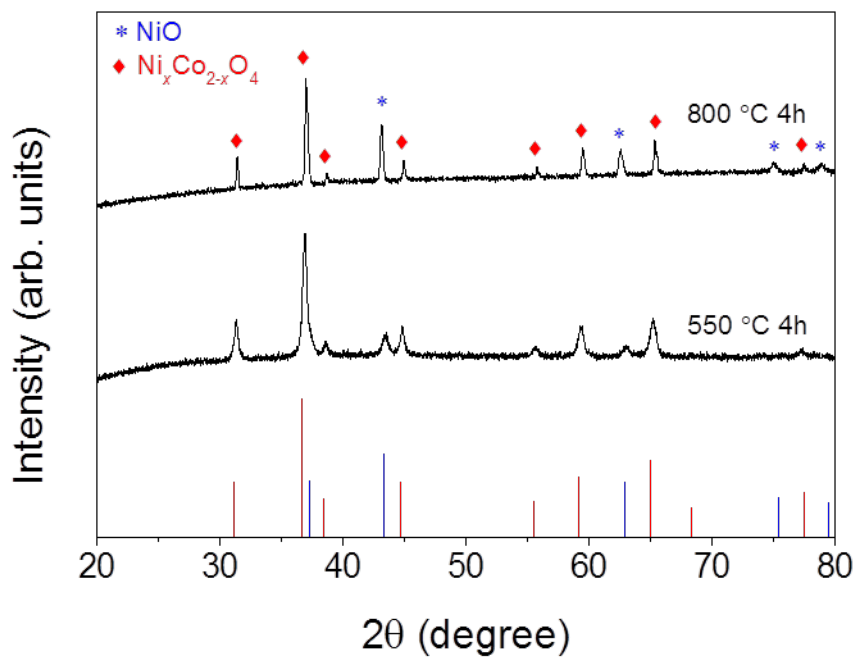


Figure S1 XRD patterns of samples prepared at 550 °C and 800 °C for 4 hours. After increasing the sintering temperature, the second phase NiO was observed.

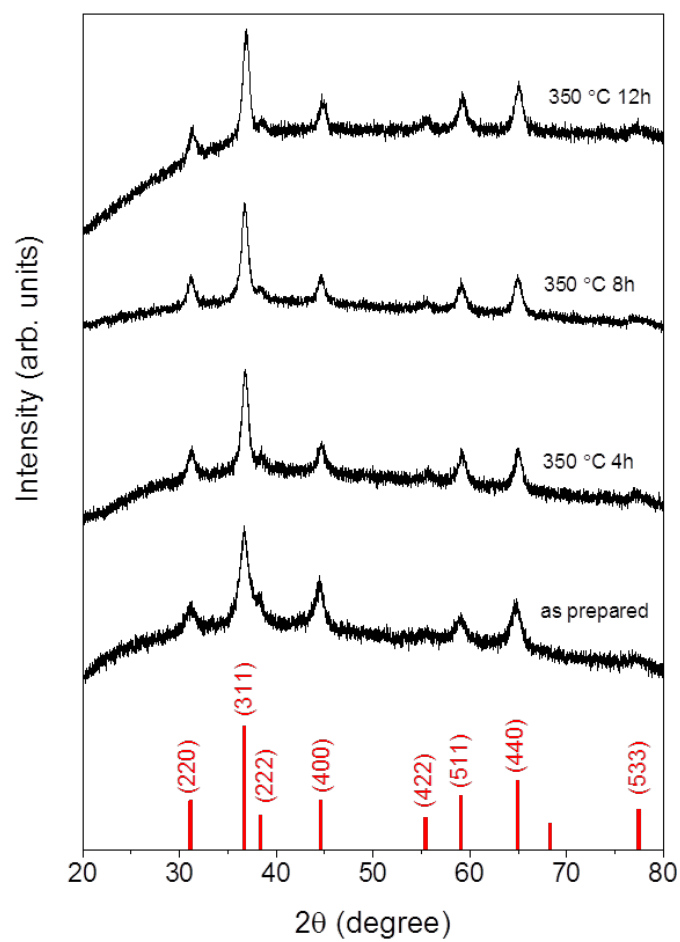


Figure S2 XRD patterns of NiCo₂O₄ annealed at 350 °C for three different periods: 4 hours, 8 hours and 12 hours. No significant changes were observed.

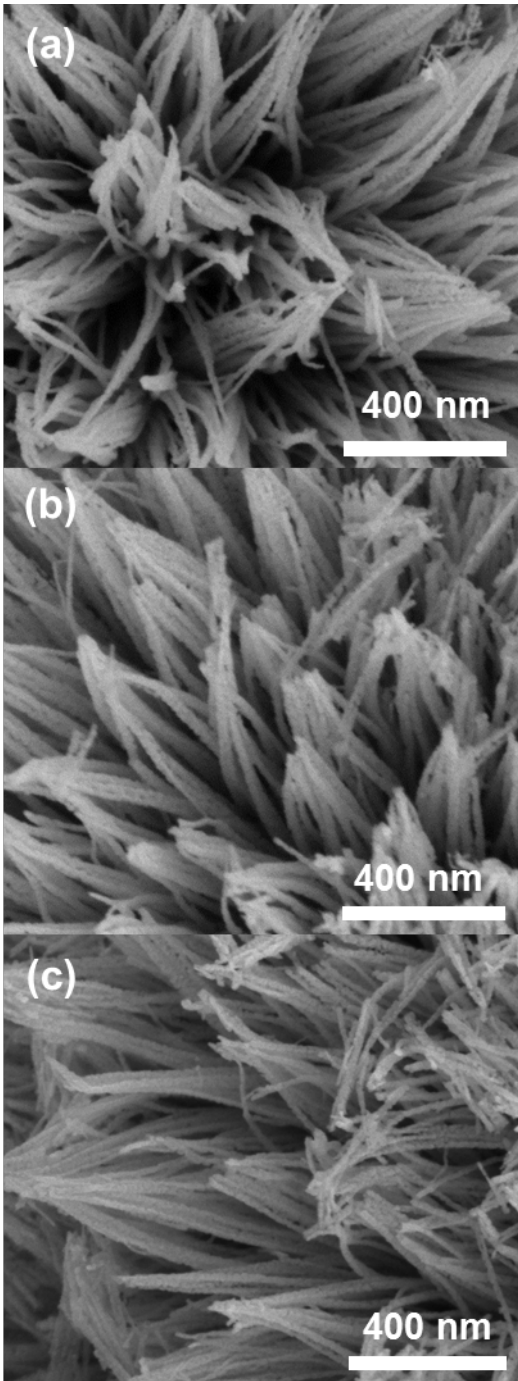


Figure S3 SEM images of NiCo_2O_4 annealed at $350\text{ }^\circ\text{C}$ and different annealing times: (a) 4 hours, (b) 8 hours and (c) 12 hours. No significant morphology changes were observed.

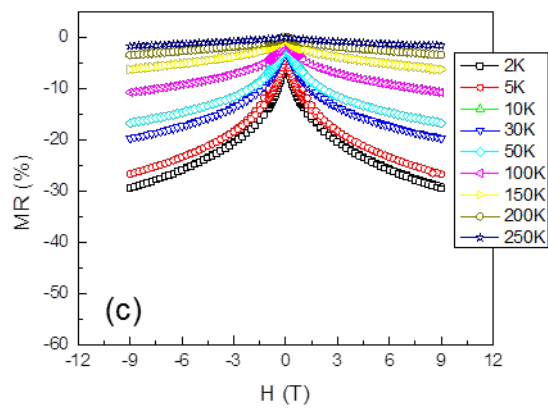
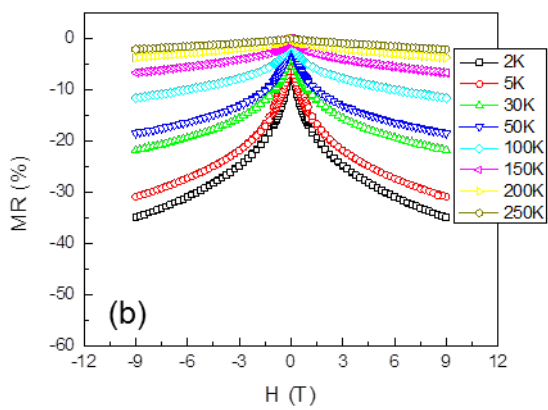
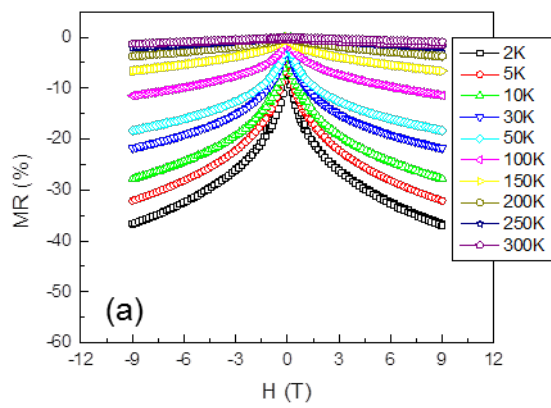


Figure S4 Field-dependent magnetoresistance of NiCo_2O_4 annealed at $350\text{ }^\circ\text{C}$ and different annealing times: (a) 4 hours, (b) 8 hours and (c) 12 hours.

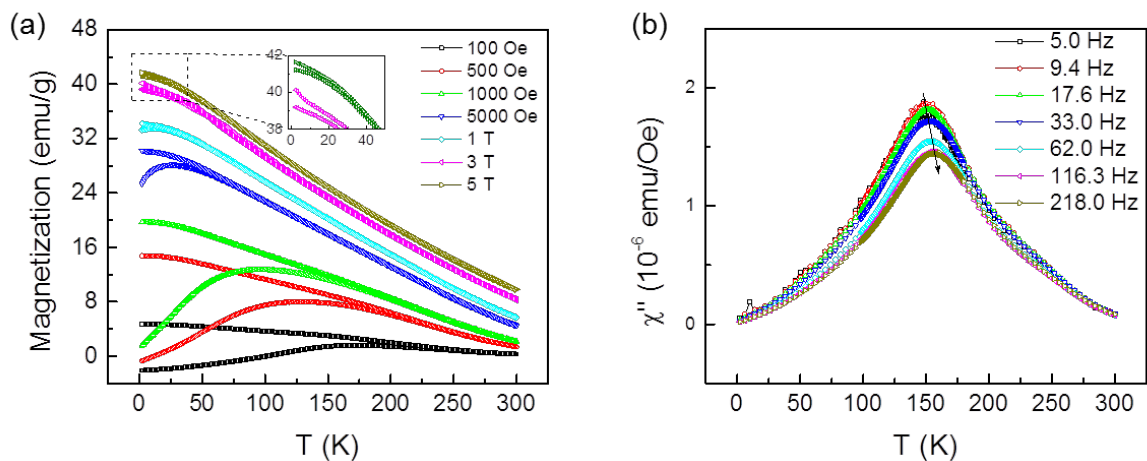


Figure S5 Demonstration of spin glass in annealed NiCo_2O_4 at $350\text{ }^\circ\text{C}$ for 12 hours. (a) Temperature dependent zero-field-cooling and field-cooling with different applied magnetic fields. (b) Temperature dependence of the out-of-phase (imaginary) part χ'' of the magnetic susceptibility at different frequencies.

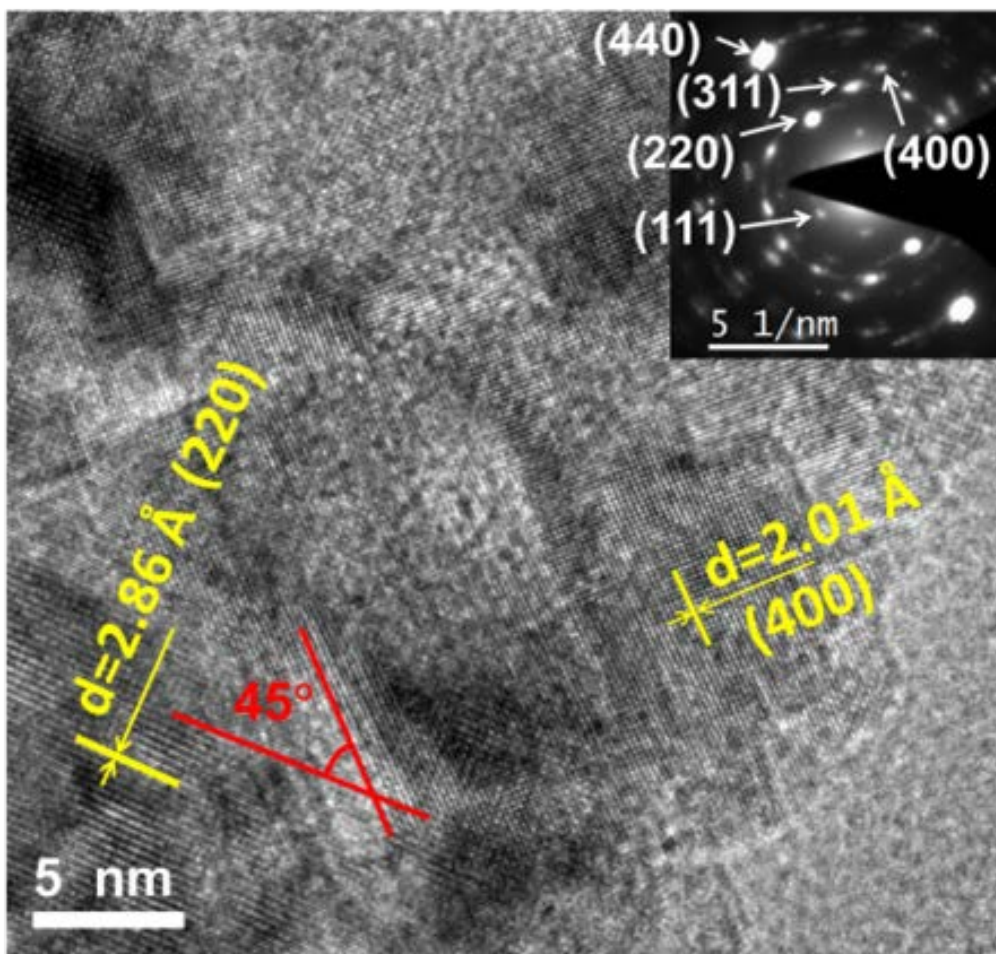


Figure S6 Demonstration of texture of NiCo₂O₄ nanotube. Typical high-resolution TEM image and oriented selected area diffraction (inset) of annealed NiCo₂O₄ nanocrystals on a nanotube. The texture of the nanotube is clearly visible.

Supplementary Note 1: Calculation method

Calculations made within the framework of density function theory were performed using the Vienna Ab-initio Simulation Package [1]. The wave functions of the inner electrons consisting of orbitals up to (and including) the 3p levels for A and B as well as the 1s level for O were described by the projector augmented wave method (PAW) [2]. Calculations were carried out on a spinel cubic cell containing 56 atoms (8 A and 16 B and 32 O) in the reciprocal space of the cell and computed with a Monkhorst-Pack grid of $4 \times 4 \times 4$ k points [3]. The optimized parameters of the 56-atom highly symmetrical unit cell were Hubbard corrected ($U_{\text{eff}}=5.5$ (Ni) and 1.5 eV (Co)).

Supplementary References

[1] G. Kresse and J. Hafner, Phys. Rev. B **47**, 558 (1993); G. Kresse and J. Furthmüller, Comp. Mater. Sci. **6**, 15 (1996).

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