Supporting Information

Ultrastable Magnetic Nanoparticles Encapsulated in Carbon for Magnetically Induced Catalysis

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S1. TEM (Transmission Electron Microscopy)

Figure S1. TEM image and size histogram of FeCo NPs stabilized by HDA/HDA•HCl.

Figure S2. TEM image and size histogram of Co NPs stabilized by HDA/HDA•HCl.

Figure S3. TEM images of a) FeCo NPs and b) Co NPs supported on carbon before the pyrolysis, FeCo/C and Co/C, respectively.
S2. STEM-HADDF and EDX

Figure S4. a) STEM-HADDF image, b-d) EDX elemental mapping and e) relative composition profile of Co@C determined by EDX.

Figure S5. a) STEM-HADDF image, b-c) EDX elemental mapping and d-e) relative composition profile of FeCo@C determined by EDX.
Figure S6. Relative composition of FeCo@C determined by EDX.

| Element | Wt%  | Wt% Sigma | Atomic % |
|---------|------|-----------|----------|
| Fe      | 45.84| 1.11      | 46.71    |
| Co      | 54.16| 1.18      | 53.29    |
| Total:  | 100.00| 100.00    |          |
S3. XRD (X-ray Powder Diffraction)

Figure S7. XRD spectra of a) FeCo@C and b) Co@C.

S4. Raman

Figure S8. Raman spectra of: a) Co@C and b) FeCo@C.
S5. TPR (Temperature-Programmed Reduction)

Figure S9. TPR profiles of a) Co@C and b) FeCo@C.

S6. XPS (X-Ray Photoelectron Spectroscopy)

Figure S10. X-ray photoelectron spectroscopy (XPS) of the Co2p signal of Co@C before (red) and after reduction by H₂ at 400 °C (blue). * correspond to the loss feature.
Figure S11. X-ray photoelectron spectroscopy (XPS) of a) Fe2p and b) Co2p areas of FeCo@C and before (red) and after reduction by H₂ at 400 °C (blue).
S7. SAR (Specific Absorption Rate).

SAR has been measured by calorimetry. An air-tight tube containing about 10 mg of heating agents dispersed in 0.5 ml of mesitylene was filled under inert atmosphere. The tube was then placed in a calorimeter containing 2.5 ml of deionized water, the temperature of which was monitored during the experiment. The calorimeter was exposed to an alternative magnetic field for a time varying between 5 and 20s so that the temperature rise never exceeded 20°C. The temperature rise at the end of the magnetic field application was always measured after shaking the calorimeter to ensure the temperature homogeneity, which was measured by two probes (at the top and the bottom of the calorimeter). The temperature rise was determined after this process from the mean slope of the $\Delta T/\Delta t$ function. Then the raw SAR values were calculated using the expression:

$$\text{SAR} = \frac{\sum_i C_{p_i} m_i}{m_{\text{met}}} \times \frac{\Delta T}{\Delta t}$$

where $C_{p_i}$ and $m_i$ are the specific heat capacity and the mass for each component respectively ($C_p = 449 \text{ J.kg}^{-1}.\text{K}^{-1}$ for Fe NPs, $C_p = 1750 \text{ J.kg}^{-1}.\text{K}^{-1}$ for mesitylene, $C_p = 4186 \text{ J.kg}^{-1}.\text{K}^{-1}$ for water and $C_p = 720 \text{ J.kg}^{-1}.\text{K}^{-1}$ for glass), and $m_{\text{met}}$ is the mass of the pure metal in the sample.

The raw SAR values were corrected from the calorimeter losses, which were previously calibrated. For the calibration, a sample containing nanoparticles displaying moderate SAR was exposed for different time periods to an alternating magnetic field of 47 mT, 100 kHz. For each time, the SAR of the sample was measured. The SAR measured for an exposure time of 5s is considered as the “real” SAR (no losses). For longer exposure
times, the difference between the measured SAR and the “real” SAR allows the determination of a corrective factor. The calibration curve is displayed below.

For each exposure time, the SAR was measured several times to ensure reproducibility. For the samples presented in this article, the measurement times were often comprised between 5 and 10s.

Temperature monitoring has been done using a thermocouple disposed in a quartz cannula disposed in the centre of the catalytic bed surrounded by the magnetic field inductor. Temperature range is 0-1300°C.
**Figure S12.** Specific absorption rate (SAR) of FeCo@C (red) and Co@C (green) measured by calorimetry in a 93 kHz AC field in ethanol (EtOH) solution.

**S8. Catalysis**

![Graph showing PDH reaction using FeCo@C/PtSn as catalyst.](image)

**Figure S13.** PDH reaction using FeCo@C/PtSn (Pt 0.5 wt %, Sn 0.75 wt %) as catalyst. Gas stream: 20 ml/min propane. Temperature was recorded by IR thermometry.
**Figure S14.** STEM-EDX observations of Co, Fe and Ni of 2:1 FeCo@C:Co@C/Ni (10 wt %) over time during PDR. As synthetized (a), after 2h on stream (b), after 6 h on stream (c) and after 8h on stream and air exposition (d). Catalysis was performed using 2:1 FeCo@C:Co@C/Ni (10 wt %), with 3:1 CO$_2$: C$_3$H$_8$ (10mL/min) at 300kHz and variable field amplitudes.