Electronic Supplementary Material (ESI) for Physical Chemistry Chemical Physics.

Electronic Supporting Information

Nanoparticle impacts reveal magnetic field induced agglomeration and reduced dissolution rates

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S.1 Magnetic field distribution

The permanent NdfeB ring magnet shown in Fig. 1 (main tarticle) generates a magnetic field that penetrates into the inside the electrochemical cell. The magnetic field distribution (more precisely the magnetic flux density distribution) *B* inside the cell was simulated using the magnetostatic field solver "Amperes 9.0" by Enginia Research Inc (Finite Element solver). The B-distribution in the vicinity of the WE is found to be very homogenous at a value of 0.31 ± 0.01 T. The distribution near the WE position is visualized in Fig. S2 as two slices of 2x2 mm^2 each in the *xy* and the *yz* plane, respectively.

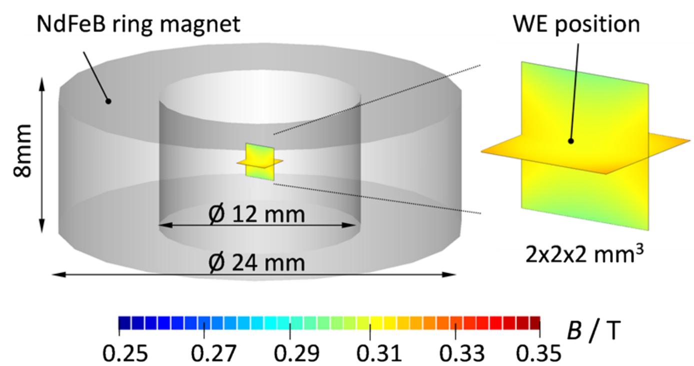

Fig. S1: Schematic drawing of the NdFeB ring magnet including the simulated magnetic field (B) distribution at the position of the WE inside the electrochemical cell. The enlarged version shows a nearly homogeneous distribution of $B = 0.31$ T in the *xy* and *yz* planes (two slices of 2x2 mm^2 each).

S.2. Size distribution of Fe_3O_4 NPs

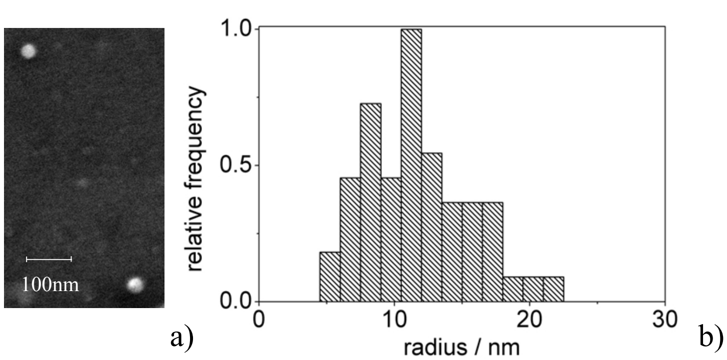

Fig. S2: SEM image of the used uncapped Fe_3O_4 nanoparticles and sized distribution of the NPs determined from SEM images; modal radius – 11 nm, mean radius = 12±4 nm.

S.3. Data Analysis

The in-house developed software SignalCounter was employed for spike identification, baseline correction and determination of spike area (= spike charge) and spike duration. Individual nominal (hydrodynamic) NP sizes were calculated from this data and to derive information on the NP ensemble histograms were drawn to derive size and duration distributions for a total of 1021 (no magnetic field) and 837 (in a magnetic field) spikes. Identical bin sizes were used for both sets of data ($2x10^{-15}$C for the charge, 0.5 nm for the size and 1 ms for the duration histograms). All histograms were normalized by dividing the obtained counts per bin through the total number of impacts and the resulting relative frequencies were plotted for better comparability of the data with and without applied magnetic field.
The mean current per spike was calculated by dividing the individual spike charge through its duration. This approximation is feasible, as at NP electrodes, such as a dissolving Fe_3O_4 NP, steady-state currents are established within less than a microsecond and thus the (multi-) millisecond current spike can be suitably described by this "mean" (i.e. steady-state or limiting) current. To plot mean currents against the corresponding spike area (or nominal NP radius, Figure 5), the areas detected in the magnetic field were binned into 8 packets of 100 spikes each and the corresponding mean currents were averaged and plotted against the bin center. For comparison, the mean currents obtained in the absence of a magnetic field were averaged over the same area bins. There, a higher number of spikes contributed to bins of lower areas, while no spikes were recorded for very high areas, so that no average mean current could be assigned to these areas (Q < -0.5 pC).
The described additional data treatment was done using Origin Pro 8.5.1 (Origin Lab Corporation).

S.4. Results

Dependence of spike charge of individual impact events against its duration

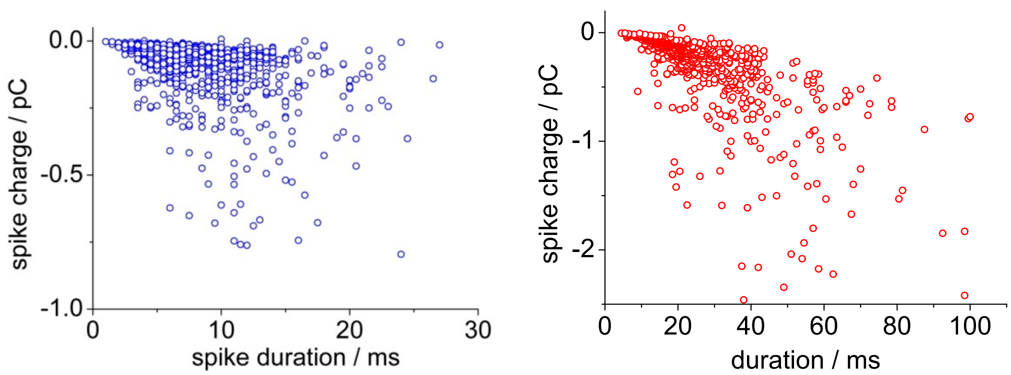

Fig. S3: Charge transferred per individual spike against its duration in absence (left) and presence (b) of a magnetic field, showing the whole range of detected values.