A Flexible lab-on-a-chip for the synthesis and magnetic separation of magnetite decorated with gold nanoparticles

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Supplementary Information

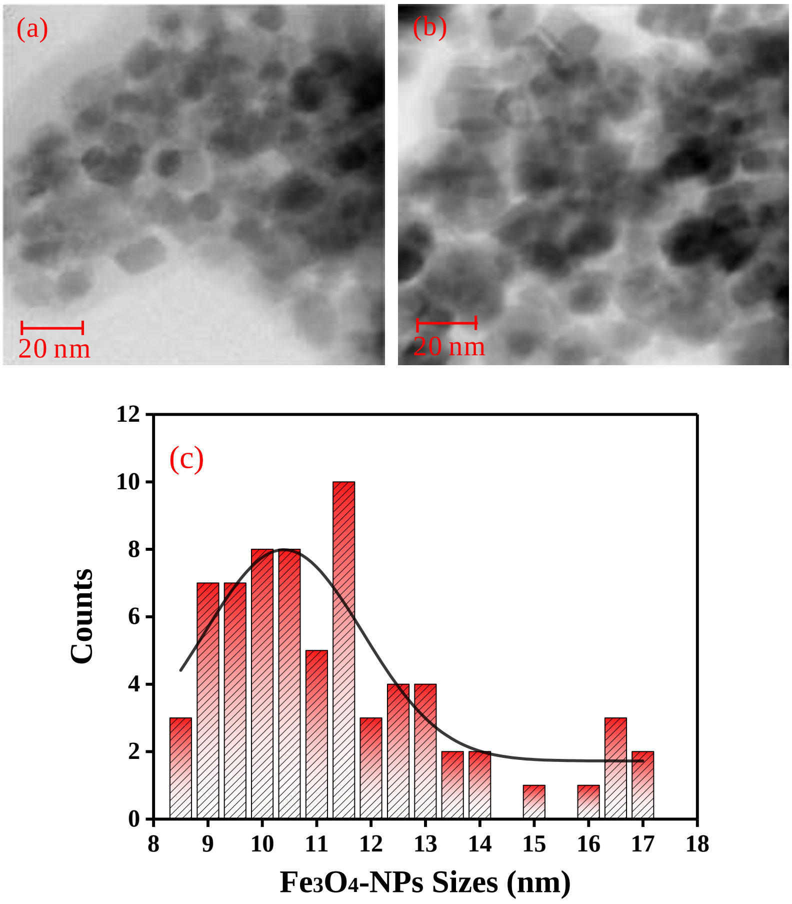

Fig. S1 (a, b) Transmission electron micrographs of Fe_3O_4-NPs synthesized by coprecipitation. **(c)** Histogram of the size distribution of Fe_3O_4-NPs with an average diameter of 10.4 ± 0.3 nm (sphere approximation).

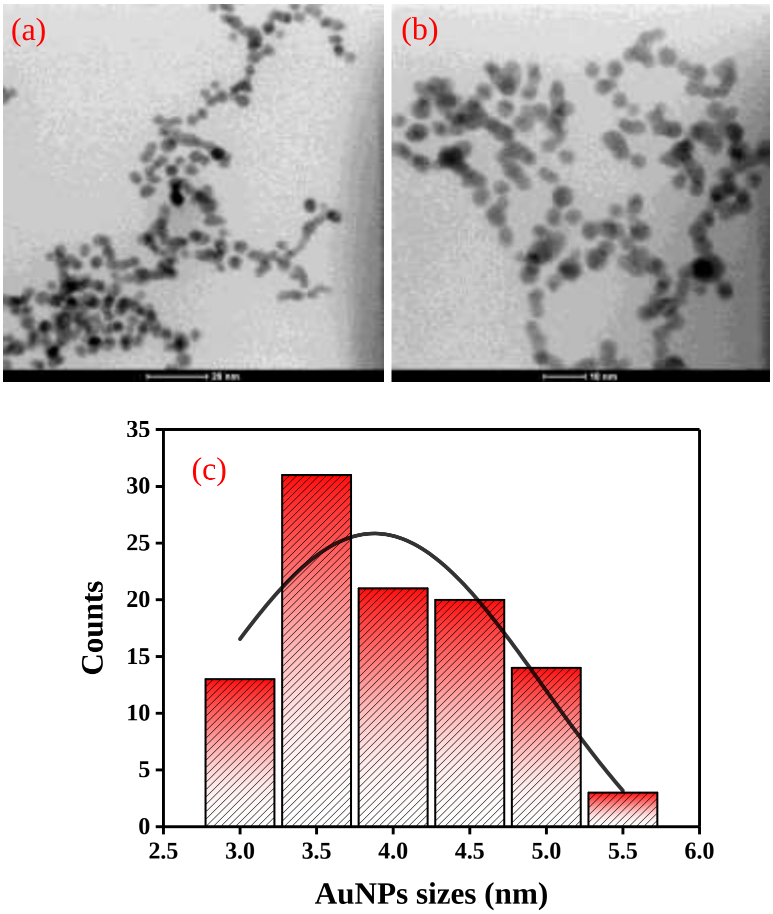

Fig. S2 (a, b) Transmission electron micrographs of AuNPs. **(c)** Histogram of the size distribution of AuNPs, with an average diameter of 3.9 ± 0.2 nm.

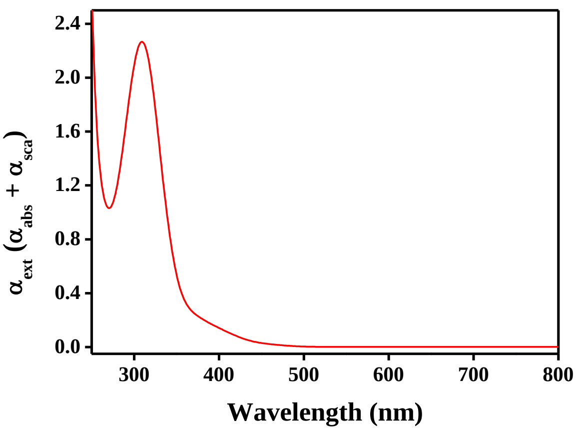

Fig S3 Ultraviolet-visible absorption spectrum obtained from an aqueous solution of $HAuCl_4$ (0.51 mmol·L^{-1}). The spectrum shows an absorption band at 310 nm.

Effect of concentrations of Fe_3O_4 NPs

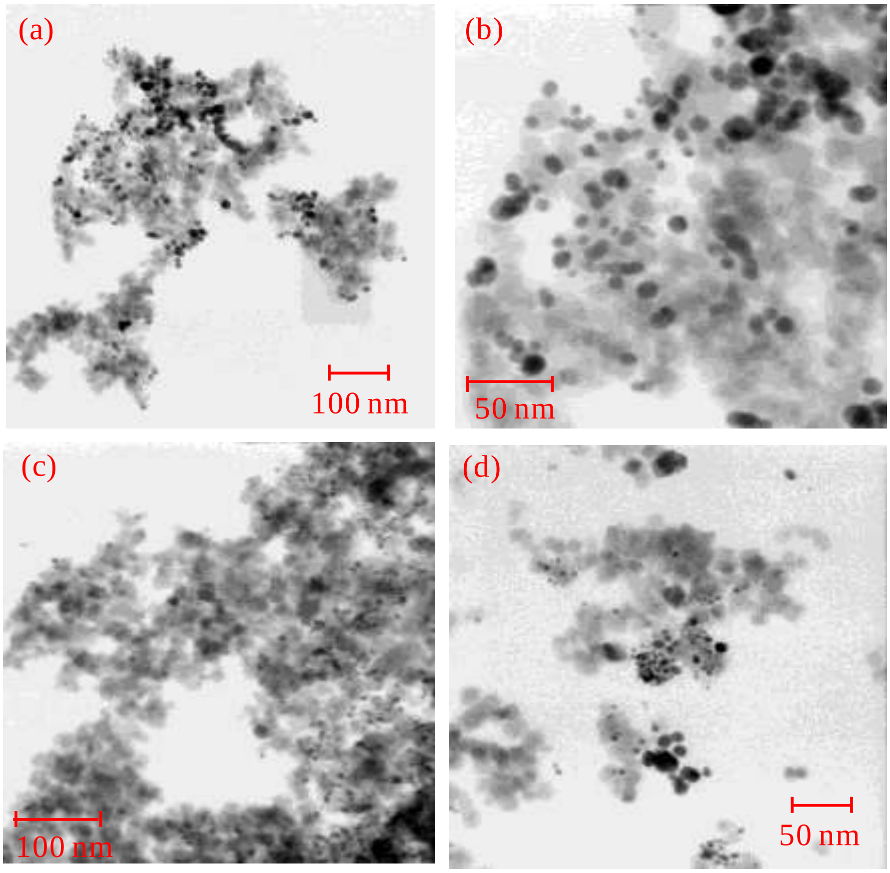

Fig. S4. Transmission electronic micrographs of Fe_3O_4-AuNPs obtained from the microfluidic device using different concentrations of Fe_3O_4-NPs; (a, b) 84.0 µg m·L^{-1} (**C_4**) and (c, d) 126.0 µg·mL^{-1} (**C_5**).

Flow rate effect

We have evaluated the effects of the flow rates on the decoration process, for instance, with 25, 50 and 100 µL min^{-1} (Fig. S5). For all those rates, similar response is observed as 63.0 µg mL^{-1}. Also, a rate of 100 µL min^{-1} became the selected one, due to it removes all AuNPs from the suspension.

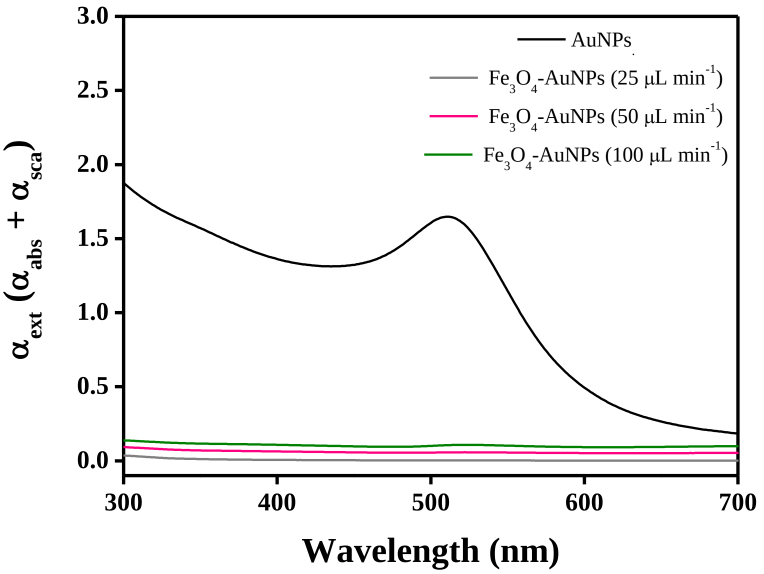

Fig. S5. UV-Vis spectra obtained from supernatants of Fe$_3$O$_4$-AuNPs decorated using 63.0 µg·mL^{-1} suspensions of Fe$_3$O$_4$-NPs, evaluated at different flow rates: 25, 50 and 100 µL min^{-1}.

Stability

Here, we show that the AuNPs are stable on Fe_3O_4-NPs surfaces. For this, Fe_3O_4-AuNPs were subjected to magnetic separation for many times (six cycles, indicated from I to VI). For each cycle, the suspension containing Fe_3O_4-AuNPs was injected into the microfluidic device, and then, subjected to magnetic separation. The supernatant was analysed, as shown in Fig. S6. The AuNPs removal from Fe_3O_4-NPs was evaluated by monitoring the plasmon resonance band at 510 nm, attributed to AuNPs. The value of 100% of absorption was considered for the original suspension (black curve) as the maximum concentration of AuNPs in the supernatant. It is clear that for all cycles AuNPs were not observed, assuring that they still on Fe_3O_4 surface.

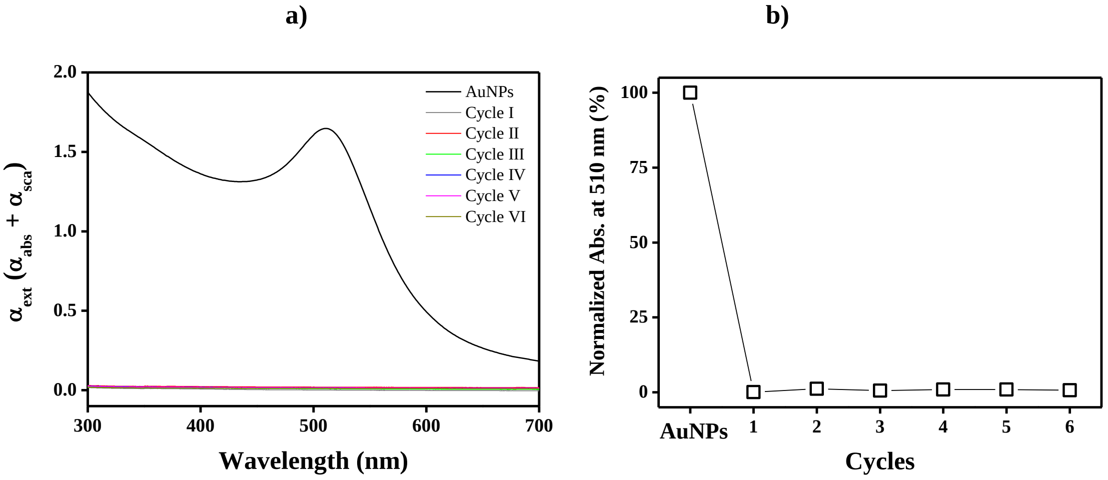

Fig. S6. a) UV-Vis spectrum obtained for AuNPs synthetized with $HAuCl_4$ (0.51 mmol·L^{-1}) (black line); and spectra for the supernatants after six cycles of re-injection in the NRMD device (coloured lines). For these experiments, the supernatants were collected after each cycle inside of the microfluidic device. The decorated Fe_3O_4-AuNPs are injected into the microfluidic device six times. The collected Fe_3O_4-AuNPs were re-dispersed in 1.0 mL of water, represented by each cycle. **b)** Plot of normalized absorbance (at 510 nm) *versus* cycles, showing the 100% absorbance for AuNPs and the supernatant absorbance for each cycle.