Kinetics of aggregation and magnetic separation of multicore iron oxide nanoparticles: effect of the grafted layer thickness

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Magnetic microbeads are commonly used in immunoassays to detect trace levels of antigens. Despite weaker magnetic attraction, we aim at developing efficient magnetic capture of multi-core magnetic nanoparticles (MNP) also called nanoflowers,[1] of outer diameter 30-60 nm, by using moderate magnetic field strengths. Recent work by some of us showed that magnetic interactions between MNPs of this size can still be strong enough to induce a reversible phase separation in the presence of a magnetic field B as weak as 10 mT.[2] During this phase separation, MNPs are gathered into micron-sized drop-like aggregates whose magnetic interaction with the applied field is much stronger than between individual nanoparticles and larger than thermal agitation k_BT. These fluid-like aggregates can then be separated from the solvent much more easily than single MNPs. Moreover, it is beneficial in continuous filtration to assemble the aggregates well before they are captured by magnetized collectors, by conveying the MNP suspension to the micro-filter across a microchannel submitted to a uniform external magnetic field H_0. This communication establishes the mechanisms of multi-core MNP capture in microfluidic channels under magnetic and flow fields, and presents a phase diagram in terms of Mason number, dipolar coupling constant, and thickness of the organic coating wrapping the multi-core MNPs: short citrate molecules or PEG chains.[3]

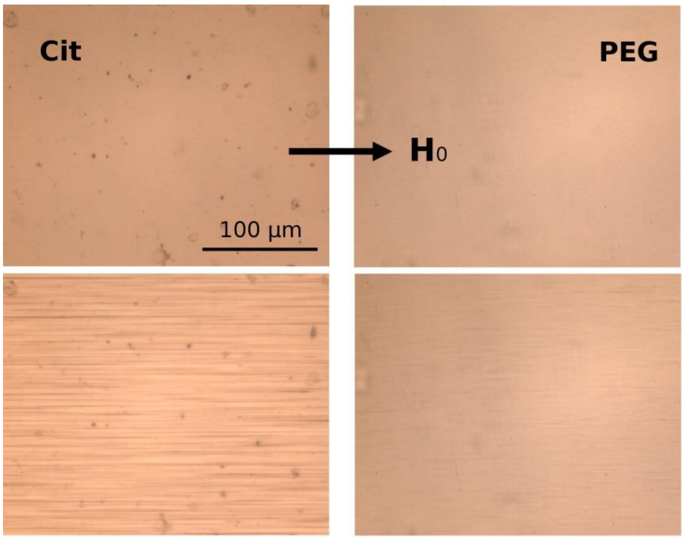

Figure 1. Snapshots of aqueous suspensions of citrated (left) and PEGylated (right) MNPs at φ_0=0.13% submitted to H_0=13.5 kA·m^{-1} at t=0 (upper row) and 5 min after field application (bottom row).

Keywords: Multi-core Magnetic Nanoparticles, Magnetic attraction, Micropillars, Microfluidics.

References

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