MAGNETOPHORESIS OF MAGNETOMIGRATION IN AQUEOUS LANTHANIDE SOLUTIONS

Isadora R. Rodrigues, a,b Liubov Lukina, a Sam Dehaeck, b Pierre Colinet, b Koen Binnemans, c & Jan Fransaer a

a Department of Material Engineering, KU Leuven, Kasteelpark Arenberg 44, P.O. Box 2450, B-3001 Heverlee, Belgium
b Université Libre de Bruxelles (ULB), TIPs (Transfers, Interfaces and Processes), CP 165/67, Av. F. D. Roosevelt 50, 1050 Brussels, Belgium
c Department of Chemistry, KU Leuven, Celestijnenlaan 200F, Box 2404, B-3001 Heverlee, Belgium

This work studies the magnetomigration of trivalent lanthanide ions (Ln3+) and the magnetophoresis of droplets containing Ln3+ ions. Magnetomigration and magnetophoresis are used to distinguish the motion of ions and small molecules from larger particles through a medium due to the presence of an external magnetic field. Hydrophilic droplets of concentrated aqueous Ln3+ solutions suspended in a hydrophobic medium develop different velocities when subjected to a magnetic field. The droplets undergo a “magnetophoretic sprinting” and their velocities are correlated to the magnetic susceptibility of the Ln3+ ions present in the droplet. The magnetophoretic motion of droplets of strongly paramagnetic Ln3+ ions was considerably faster compared to that of droplets of weakly paramagnetic ones. Droplets containing diamagnetic ions (La3+ and Lu3+) were not affected by the magnetic field. When the velocity was plotted as a function of the atomic number, a binodal-shaped curve was obtained, similar to that of the effective magnetic moments. This shape reflects changes of the magnetic susceptibility across the lanthanide series. In recent studies, Mach-Zehnder interferometry (MZI) was used to investigate the magnetomigration of Dy3+ ions in aqueous solutions. Despite these recent reports, the magnetically induced motion of small molecules and ions is still controversial. Brownian motion of ions at room temperature should overpower the magnetomigration of the ions.

To validate this, a careful experiment was performed in which a homogenous Dy3+ solution was exposed to an external magnetic field. No migration of ions was detected. However, when a concentration gradient was introduced in the solution by solvent evaporation, consistent migration of paramagnetic Dy3+ ions was observed. This is an important observation to explain the mechanism of the magnetic motion of ions described in the literature.

Figure 1. Magnetophoresis of a Dy3+-containing droplet inside paraffin oil.

References