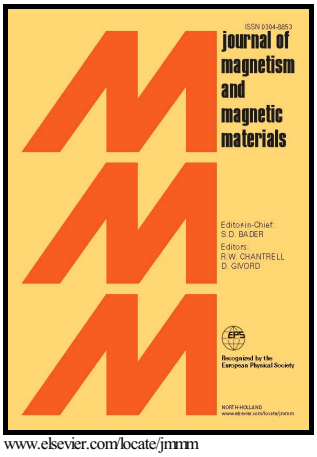


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# Magnetic filtration of phase separating ferrofluids: from basic concepts to microfluidic device

P. Kuzhir[1*], C. Magnet[1], H. Ezzaier[1,2], A. Zubarev[3], G. Bossis[1]

[1]University of Nice Sophia Antipolis, CNRS UMR 7336, Laboratory of Condensed Matter Physics, Parc Valrose, 06108 Nice Cedex 2, France

[2]Laboratory of Physics of Lamellar Materials and Hybrid Nano-Materials, Faculty of Sciences of Bizerte, University of Carthage, 7021 Zarzouna, Tunisia

[3]Department of Mathematical Physics, Ural State University, 51, Prospekt Lenina, Ekaterinburg 620083 Russia

[*]Corresponding author: kuzhir@unice.fr

## Abstract

In this work, we briefly review magnetic separation of ferrofluids composed of large magnetic particles (60 nm of the average size) possessing an induced dipole moment. Such ferrofluids exhibit field-induced phase separation at relatively low particle concentrations (~0.8%vol.) and magnetic fields (~10 kA/m). Particle aggregates appearing during the phase separation are extracted from the suspending fluid by magnetic field gradients much easier than individual nanoparticles in the absence of phase separation. Nanoparticle capture by a single magnetized microbead and by multi-collector systems (packed bed of spheres and micro-pillar array) has been studied both experimentally and theoretically. Under flow and magnetic fields, the particle capture efficiency $\Lambda$ decreases with an increasing Mason number for all considered geometries. This decrease may become stronger for aggregated magnetic particles ($\Lambda \propto \mathrm{Ma}^{-1.7}$) than for individual ones ($\Lambda \propto \mathrm{Ma}^{-1}$) if the shear fields are strong enough to provoke aggregate rupture. These results can be useful for development of new magneto-microfluidic immunoassays based on magnetic nanoparticles offering a much better sensitivity as compared to presently used magnetic microbeads.

**Keywords**: phase separation; ferrofluid; magnetic colloids; magnetic separation

## 1. Introduction

Magnetic separation is a process in which magnetically susceptible particles are extracted from a mixture using a magnetic force. It has found numerous applications in ore beneficiation industry [1], in bio-analysis for separation or detection of biological cells or molecules [2] as well as in water purification from organic or inorganic micro-pollutants [3].