Surface-selective hybridization of magnetic nanoplatelets for the manipulation of ferrofluids with magnetic and electric fields

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We demonstrate a proof-of-concept for coupling electric and magnetic dipoles within a nanoparticle using a surface-selective hybridization technology [1]. The magnetic and electric dipoles, which are aligned orthogonally to the basal plane of barium hexaferrite nanoplatelets, ensure the magnetic and electrical sensitivity of these nanohybrids and their dispersions. While the origin and alignment of the magnetic dipole are intrinsic to the core barium hexaferrite nanoplatelets, the electric dipole is induced by a monolayer assembly of polar ligands on a single basal plane of the nanoplatelets (Figure 1). The specific ligand structure, containing a push-pull segment, a strong phosphonic anchor, and a solvent-adjustable backbone, aligns the electric dipole orthogonally to the nanoplatelet basal plane.
The surface-selective hybridization is achieved by hybridizing the exposed basal plane of the nanoplatelets assembled on a substrate under an applied magnetic field, followed by harvesting of the magneto-electric nanohybrids and their dispersion in nonconductive solvents. The coupled dipolar response was confirmed by our custom-made technique, a multidipole electrophoresis in a magnetic field (Figure 1), and by the external-field-induced optical birefringence.

Keywords:
magneto-electric, nanoplatelet, hybridization, ferrofluid, external field, electrophoresis

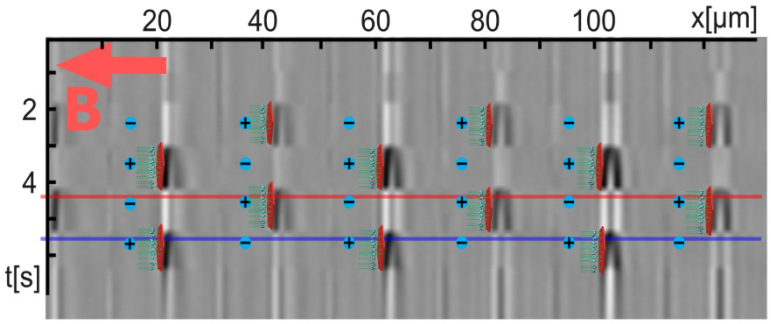

Figure 1. Multidipolar electrophoresis: the presentation of a magneto-electric dipolar response of dispersed Janus nanohybrids. The magnetic field (B) direction is denoted by a red arrow, while the electric charge of the electrodes is denoted by plus and minus.

References:

[1] Ali Tufani, Jošt Ručl, Peter Medle Rupnik, Tomaž Gregorec, Simon Pevec, Tomáš Landovský, Martin Cigl, Vladimíra Novotná, Denis Đonlagić, Alenka Mertelj, Darja Lisjak , Coupling Electric and Magnetic Dipoles in Janus Nanoplatelets via Surface-Selective Hybridization. ChemRxiv. 19 March 2026, DOI: https://doi.org/10.26434/chemrxiv-2026-mf0tj/v2

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