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Measuring the rotational viscosity of ferrofluids without shear flow

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Abstract

The shear free solid-body rotation of an ordinary fluid is undamped. But a ferrofluid experiences in a magnetic field a damping due to internal *rotational* friction of the nanoscale magnetic particles in the suspension. The rotational viscosity of different ferrofluids undergoing shear free solid-body rotation is determined directly by measuring the associated magneto-viscous dissipation rate in a resonance experiment with a torsional pendulum. The data are fitted to a simple mesoscopic model for the related transverse magnetic relaxation time based on monodisperse, non-interacting rigid dipoles. In this way the average size of the magnetic particles and their hydrodynamic diameter (core plus surfactant coating) are deduced under *in-situ* conditions, i.e. without diluting the sample. The reliability of the method is demonstrated by comparing the results with those of the complementary techniques of magneto-granulometry, X-ray diffraction, electron microscopy, and photon-correlation spectroscopy.