P.18 Influence of magnetic field on the orientation of anisotropic magnetic particles at liquid interfaces

B J Newton and D M A Buzza

Department of Physics and Mathematics, University of Hull, UK

We study theoretically the influence of an external magnetic field on the orientation of both ellipsoidal and cylindrical particles with a permanent magnetic dipole adsorbed at a liquid interface. The ability to control the orientation of such anisotropic magnetic particles allows us to manufacture novel materials with tunable mechanical, magnetic or photonic properties [1,2]. Specifically, using the finite element package Surface Evolver [3], we calculate the equilibrium meniscus shape around the anisotropic particles and equilibrium tilt angle when a magnetic field is applied perpendicular to the interface, inducing a magnetic torque on the anisotropic particles (see Fig.1). At zero field, the particles have a 'parallel' orientation ($\theta_t = 0$). However as we increase field strength, the equilibrium tilt angle θ_t increases, and at a critical magnetic field B_c and tilt angle θ_{tc}, the particles undergo a first order phase transition to the perpendicular orientation ($\theta_t = 90°$). We find that the critical field B_c increases with increasing aspect ratio of the anisotropic particles but decreases with increasing contact angle away from 90°. These results are in qualitative but not quantitative agreement with the simplified theory proposed by Bresme and Faraudo [1] which assumes that the liquid interface is always flat. Our study demonstrates the importance of explicitly accounting for the deformation of the liquid meniscus for quantitative calculations of the orientation of magnetic anisotropic particles in an external field.

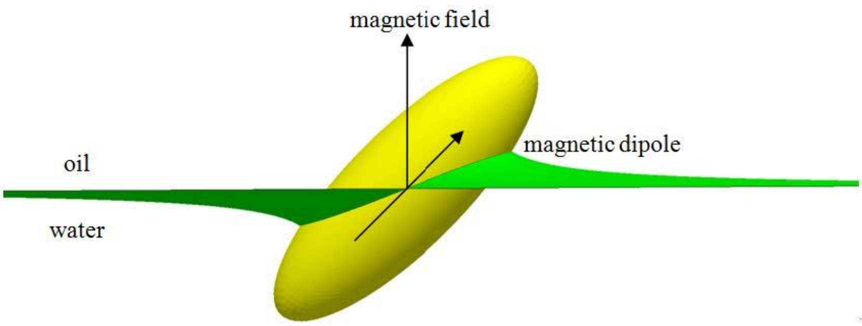

Figure 1: Surface Evolver image of an ellipsoidal particle adsorbed at a liquid interface in an external magnetic field perpendicular to the liquid interface.

[1] F. Bresme and J. Faraudo, J. Phys.: Condens. Matter 19 (2007) 375110
[2] C. Raufaste and S. Cox, Colloid Surface A 438 (2013) pp 126-131
[3] K. Brakke Exp. Math. 1 (1992) pp 141-165