[Supporting Information]

Magnetically Characterized Molecular Lubrication between Biofunctionalized Surfaces

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Trajectory simulation of particle motion

The equation of particle motion in liquid medium under net forces is described as following,[1]

$$\delta V\vec{a} = \vec{F}_{mag} + \vec{F}_D = \vec{F}_{mag} + \vec{F}_f + \vec{F}_{vis} \qquad (1)$$

In this equation, δ is the density of the particle (kg m^{-3}), V is the volume of the particle (m^3), $\vec{a}$ is the acceleration of the particle, $\vec{F}_{mag}$ is the magnetic force, $\vec{F}_D$ is the drag force (the Stokes force), $\vec{F}_f$ and $\vec{F}_{vis}$ are frictional and viscous forces. Thus, in cylindrical coordinate the acceleration of the particle is given by,

$$a_\rho = (F_{mag}^{\rho} + F_f^{\rho} + F_{vis}^{\rho})/\delta V \qquad (2)$$

$$a_\varphi = (F_{mag}^{\varphi} + F_f^{\varphi} + F_{vis}^{\varphi})/\delta V \qquad (3)$$

Subsequently, differences in radial distance (ρ) and phase angle (φ) are given by the time variation (Δt) as following,

$$\Delta\rho = a_\rho \Delta t^2 \qquad (4)$$

$$\Delta\varphi = a_\varphi \Delta t^2/\rho \qquad (5)$$

As a result, the time variation of trajectory in circumferential and radial components of particle motion was numerically obtained using the above equations.

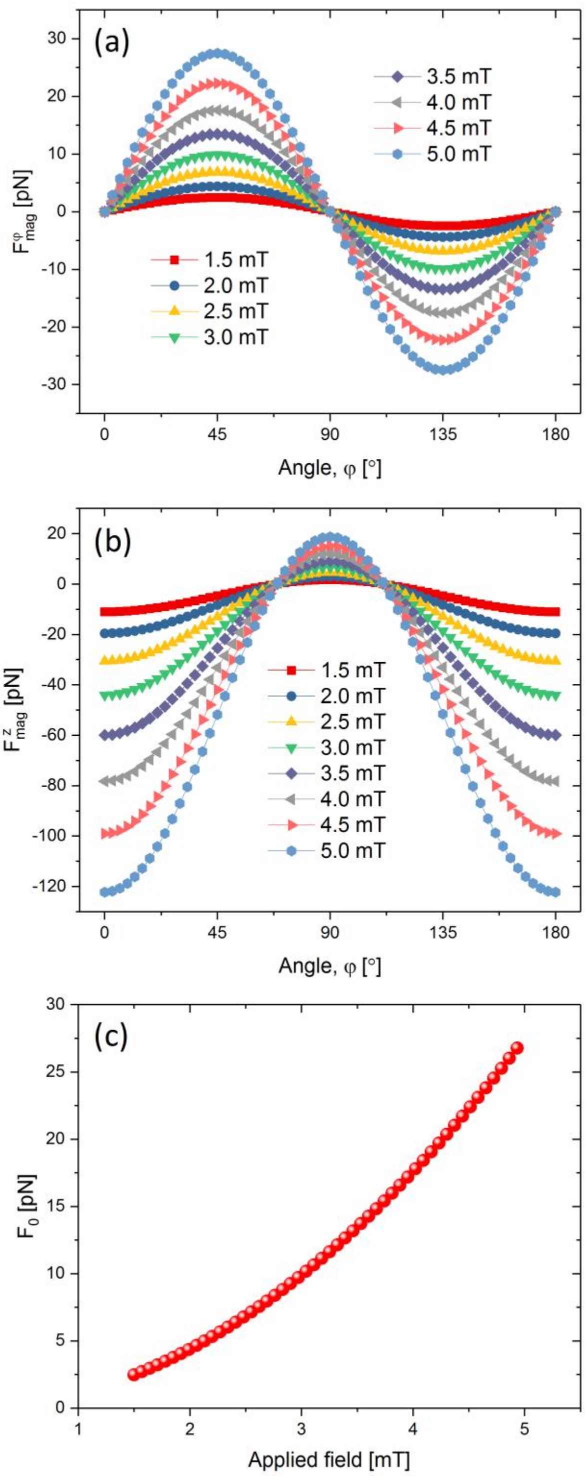

Figure S1. (a and b) Angular dependence of the magnetic forces, $F_{mag}^{\emptyset}$ and F_{mag}^{z}, on a superparamagnetic particle with a diameter of 2.8 µm and a magnetic susceptibility of 0.7 around a micromagnet under in-plane fields from 1.5 to 5 mT. (c) Magnitude of F_0 as a function of the field strength.

Reference

(1) Shevkoplyas, S. S.; Siegel, A. C.; Westervelt, R. M.; Prentiss, M. G.; Whitesides, G. M. The Force Acting on a Superparamagnetic Bead Due to an Applied Magnetic Field. *Lab. Chip* **2007**, *7* (10), 1294–1302.