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Exploring anisotropic magnetic particles as optical probes for microscaled magnetic stray field landscapes

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Recently, magnetic domain patterns engineered in thin film systems have been used profoundly in data storage, spintronics, and magnetic imaging. Characterizing the micron-scaled magnetic stray fields emerging from these patterns remains topical but challenging [1]. Optical tracking of anisotropically shaped magnetic particles aligning with the stray fields may offer a technologically simple, non-mechanical solution. Using 2-photon polymerization lithography and the deposition of a magnetic exchange-biased thin film system, we fabricated particles with custom shapes and magnetic anisotropies. They are positioned within the magnetic field landscape of a periodically patterned substrate, surrounded by a quiescent liquid. We show that our particles can be used to visualize the effective magnetic field direction optically through their spontaneous orientations and reorientations. Adjusting the particle shape, we study different scenarios for the most effective local field probing. The static fields of the domain-patterned substrates [2], when modified by external fields in the presence of our field-probing particles, additionally allow for their controlled actuation. This enables the probing of different sample areas and benefits microfluidic diagnostic and biomedical applications [3].

References

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