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Hyuk-Sang Kwon, Chen-Yuan Dong, Jason D B Sutin, Hayden Huang, Enrico Gratton, and Peter T C So.

Optimizing the design of a magnetic micro-manipulation microscope for cellular and single molecular studies.

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Abstract

We designed and optimized a magnetic micro-manipulator microscope intended for biological applications at the cellular and single molecular level. In our 8-pole design, samples mounted with magnetic particles placed at the trap center can experience 3-D uniform force or torsional stress. The poles are designed and positioned to allow a high numerical aperture, water immersion objective (NA 0.9, Zeiss Achroplan) with 1.46 mm of working distance to be used. Combined with optimized wire winding and implementation of back irons, magnetic field and gradient is localized to the sample region. By placing the sample at the center of the micro-manipulator, 3-D mechanical manipulation of the specimen can be achieved. Our system is capable of exerting force on the order of 800 pN per ferromagnetic particle 5 μm in diameter. We will present data showing the 3-D force and torque calibration. Biological applications of this magnetic micro-manipulation microscope will be discussed. In particular, 3-D mechanical stressstrain response of cells and the effects of torque on the binding of ligands to single DNA molecules will be discussed.