Electromagnetic tweezers for manipulation of colloids and living microorganisms

Jaakko V. I. Timonen[1] & Bartosz A. Grzybowski[2]

[1] *School of Engineering and Applied Sciences, Harvard University, Massachusetts, U.S.A.*

[2] *IBS Center for Soft and Living Matter and the Department of Chemistry, UNIST, Ulsan, South Korea*

Optical and magnetic tweezers have been extensively applied to manipulation of colloids and measurement of forces at microscopic scales. In this work, we will present a new method for manipulation of individual non-magnetic microobjects. The method is based on immersing the microobjects in a medium of high magnetic susceptibility (e.g. solution of a paramagnetic salt or suspension of magnetic nanoparticles). A microfabricated coaxial wire with a non-magnetic core and soft ferromagnetic shell is inserted into the solution, in order to create a movable magnetic trap for the microobjects. The trap can be turned on and off simply by magnetizing and demagnetizing the ferromagnetic shell with a small external field. The magnetic trap can capture, move, and release various non-magnetic microobjects ranging from large (ca. 50 micron) silica beads to colloidal silica (ca. 1.5 micron) and to living cells. In addition to single-colloid/cell manipulation, our method can be used also for controlled crystallization of larger assemblies of colloids and cells. Geometries of the assemblies are easily adjusted by varying the cross-section of the coaxial wire.