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Magnetic nano-structures for the manipulation of individual nano-scale particles in bio-compatible environments

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The manipulation of geometrically constrained magnetic domain walls (DWs) in nanoscale magnetic strips has attracted much interest recently, with proposals for prospective memory and logic devices. Here we demonstrate that the high controllability of the motion of geometrically constrained DWs allows for the manipulation of individual nanoparticles carrying proteins or cells in solution on a chip with the active control of position at the nanometer scale. Our approach exploits the fact that magnetic nanoparticles in suspension can be captured by a DW, whose position can be manipulated with nanometer scale accuracy in specifically designed magnetic nanowire structures. We hereby show that the precise control over DW nucleation, displacement, and annihilation processes in such nanostructures allows for the capture, transport and release of magnetic nanoparticles. Although this application of nano-magnetism to bio-technology and nanomedicine is still in its infancy, it already reveals its huge potential as one example of the synergetic combination of nano-physics, nano-chemistry and nano-biotechnology.