Voltage-induced coercivity reduction in nanoporous alloy films and patterned structures: a boost towards energy-efficient magnetic actuation

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Magnetic data storage and magnetically actuated devices are ultimately controlled by magnetic fields generated using electric currents. This involves significant power dissipation by Joule heating effect. To optimize energy efficiency, manipulation of magnetic information with lower magnetic fields (i.e., lower electric currents) is desirable. This can be accomplished by reducing the coercivity of the actuated material by, for example, an externally applied DC voltage (i.e., electric field).

A drastic reduction of coercivity is observed at room temperature in relatively thick (200–600 nm), nanoporous (pore wall width < 10 nm) Cu-Ni and Co-Pt films, prepared by micelle-assisted electrodeposition, by simply subjecting them to the action of an electric field [1]. The voltage is applied across an electrical double layer using a non-oxidative liquid electrolyte (propylene carbonate with Na^+ solvated species). *Ab-initio* calculations indicate that this effect, which is even more pronounced in patterned nanoporous structures, is mainly ascribed to changes in the magnetic anisotropy energy stemming from electric field-induced spin-dependent modifications of the magnetic density of states at the surface of the pore walls.

The large surface-area-to-volume ratio and the ultra-narrow pore walls of the system allow the whole film, and not only the topmost surface, to effectively contribute to the observed magnetoelectric effect. This allows for the observation of voltage-driven changes in coercivity that are much larger than those observed in some previous studies [2]. The voltage-induced decrease of coercivity could be used as an alternative to thermally-assisted magnetic writing in magnetic recording applications, since the latter is less energetically effective. The results from this work also serve to expand the already wide range of applications of nanoporous materials (hitherto in areas like energy storage or catalysis) and it opens new paradigms in the fields of spintronics, computation and magnetic actuation in general.

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