Sensors and actuators based on magnetic wires and nanowires

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Magnetic amorphous and nanocrystalline wires and microwires obtained by rapid quenching from the melt show specific magnetic characteristics determined by their disordered or partially disordered structures, but also because of the cylindrical symmetry which cause the formation of magnetic domains structures extremely favourable to different applications, with a special emphasis on magnetic sensors.

In this paper, different types of magnetic field sensors, displacement and torsion sensors will be presented in connection with the specific properties of magnetic wires. Special emphasis will be on the description of magnetic sensors based on magnetic glass-coated microwires, mainly used for security, electronic surveillance, antitheft and shielding in the microwave region applications. The particularities and performances of such sensors will be discussed considering the magnetic domains structure of the microwires, which is strongly dependent on the equilibrium between the magnetoelastic and magnetostatic energies [1]. The magnitude of the different terms of the total magnetic energy is modifying as a function of the metallic core diameter, the thickness of the glass coating, and the magnetostriction constant of the microwires. Considering all these aspects, a few recent applications of the magnetic wires in biosensors for the detection of biomolecules will be presented.

The recent development of magnetic nanowires [2,3] electrodeposited in the nanopores of alumina or polycarbonate membranes, offers new and multiple possibilities for the design and fabrication of miniaturized magnetic sensors and actuators. Two types of magnetic sensors and actuators based on magnetic nanowires arrays will be presented in connection with their applications: (i) "bar-code" type biosensors using combinations of magnetic (mainly amorphous Fe and Co-based alloys) and nonmagnetic (mainly noble metals) multilayered nanowires, for multiple biomolecules detection and manipulation; (ii) magnetostrictive actuators based on magnetostrictive nanowires arrays in combination with MR sensors for cochlear implants. The applications of different multilayered nanowires arrays, consisting in suitable combinations of magnetic and non-magnetic layers, in spin-valve devices will be discussed, too.

Support from the Romanian PN II – Partnerships Programme (Contracts No. 11-072/2007 and 12-114/2008) and NUCLEU Programme (PN 09-43 02 02) is highly acknowledged.

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