Anisotropy of Assemblies of Densely Packed Co-Alloy Nanoparticles Embedded in Carbon Nanotubes

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Abstract. We report on the magnetic properties of an array of binary metal CoFe, CoNi, and CoPt nanoparticles (NPs) embedded inside vertically oriented carbon nanotubes (CNTs). Samples were synthesized by chemical vapor deposition activated by current discharge plasma and hot filaments. Assemblies of Co-based catalytic NPs were prepared on SiO2/Si substrates by sputtering ultrathin films followed by reduction in an H2/NH3 mixture. As a result of the CNT growth, each CNT contained only one ferromagnetic NP located at the top. For all samples, the easy axis of magnetization was along the CNT axis. The magnetic parameters, including effective anisotropy constant and the contributions of dipole interactions and shape, magnetocrystalline, and magnetoelastic anisotropies, were estimated based on the experimental data and a random-anisotropy model. The magnetoelastic contribution was decisive. From the magnetoelasticity, the stresses in the NPs embedded in the CNTs were determined. Finally, the magnetization distribution in CoFe, CoNi, and CoPt NPs was simulated considering the magnetoelastic contribution.

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