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Synthesis and properties of ferromagnetic nanostructures embedded within a high-quality crystalline silicon matrix GIRISH MALLADI, State Univ of NY - Albany, MENGBING HUANG, THOMAS MURRAY, STEVEN NOVAK, AKITOMO MATSUBAYASHI, VINCENT LABELLA, HASSARAM BAKHRU, SUNY College of Nanoscale Science and Engineering — Ferromagnetism in transition metal implanted Si has been reported earlier but unavoidably high density of structural defects in such materials render the realization of spintronic devices unviable. We report an implantation approach enabling the synthesis of a ferromagnetic layer within a relatively defect free Si environment using an additional implant of hydrogen (range: $\sim$ 850 nm) in a region much below the metal implanted layer (range: $\sim$ 60 nm). Upon annealing at different temperatures, nanocavities created within the H-implanted region act as gettering sites for the implanted metal, forming metal nanoparticles ($\sim$ 10-25nm and density $\sim$ 10^{11}/cm2) in Si region of excellent crystal quality. The magnetization properties measured using a SQUID magnetometer show transition from superparamagnetism to ferromagnetism-like, with ferromagnetism persisting at 300K. This transition is attributed to changes in both the amount of Ni in the nanoparticles and inter-particle distances using SIMS and RBS. RBS/Channeling and TEM show a fully recovered crystalline Si adjacent to these Ni nanoparticles. The magnetic switching energy barrier, $\sim$ 0.86 eV, is about order of magnitude higher compared to nanoparticles on Si surface or silica matrices. Preliminary electrical measurements on these devices show $\sim$ 10% MR at 1T, 300K. These results show promise towards implementing spintronic devices in Si.

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