FePt Ordered Alloy Nanoparticles Produced by Ion Implantation

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We have used sequential implantation of Fe and Pt followed by thermal annealing to produce ordered Fe_xPt_{1-x} alloy nanoparticles in Al_2O_3. The nanoparticles are oriented with respect to the Al_2O_3 matrix, and we have produced nanocomposites with either single or multiple orientations of the nanoparticles. Particle size varies from a few nm to ~100 nm depending on the implantation and/or annealing conditions. By changing the relative doses of Fe and Pt, we have produced nanocomposites where the Pt atomic fraction [Pt/(Pt + Fe)] varies from ~25% to ~53%. In the range of 35% to 53% atomic percent Pt, the chemically ordered $L1_0$ phase of FePt is formed with an order parameter that approaches unity. These nanoparticles are ferromagnetic and have a very high coercive field that maximizes at a Pt atomic fraction of ~45%. For this case, the coercive field exceeds 2 Tesla at 30K, and is greater than 1.5 Tesla at room temperature. At lower Pt atomic fractions (~25%), the chemically ordered $L1_2$ phase of Fe_3Pt is formed. By similar methods, we have produced FePt alloys in several other matrices including SiO_2, MgO, and Y stabilized zirconia (YSZ). We are exploring the use of ion implantation to produce other ordered alloys with the $L1_0$ structure in Al_2O_3. These include CoPt, $Fe_{0.5}Co_{0.5}Pt_1$, and NiPt.

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