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Ion synthesis and FMR studies of iron and cobalt nanoparticles in polyimides

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Abstract

Polyimide foils were implanted with 40 keV Fe^+ and Co^+ to doses of $0.25–1.5\times10^{17}$ ions/cm^2. Electron microscopy studies showed the formation of iron and cobalt nanoparticles in the implanted polymer layer with a thickness of about 70 nm. The size and shape of the ion-synthesized metal nanoparticles depend on the implantation parameters and subsequent thermal annealing. A ferromagnetic resonance (FMR) response was found in the iron-implanted samples as well as in the annealed cobalt and iron samples. The effective magnetization values of the metal/polymer composite layers were extracted from the FMR spectra and plotted as a function of implantation dose. The magnetic properties of the iron and cobalt nanoparticles in polyimide are compared and discussed.

Keywords: Ion implantation; Magnetic nanoparticles; Granular magnetic films; Ferromagnetic resonance

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1. Introduction

The synthesis and characterization of nanosize magnetic particles are the subject of intense scientific research. This activity is inspired by the crossover phenomena related to quantum-size effects as well as the important applications of nanostructured magnetic materials in magnetic recording and information storage, magneto-sensor electronics, magnetic resonance imaging enhancement, ferrofluids, magnetic refrigeration, colour imaging, medical diagnostics, etc. [1].

Nanocrystalline cobalt and iron particles are among the most promising candidates for high-density recording media [2] and magnetic sensors based on the giant tunnel-type magnetoresistance effect [3]. Dielectric matrices are usually used as the host for the nanocrystalline particles, to stabilize the metal granules against oxidization and prevent coalescence. Among the different techniques, ion implantation is a very attractive and prospective preparation method because of its peculiar advantages, such as easy

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