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RAPID ANNEALING AND SUBSTRATE TEMPERATURE EFFECTS ON MAGNETIC PROPERTIES AND FERROMAGNETIC RESONANCE OF CoFeV SOFT MAGNETIC THIN FILMS

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In order to apply Co-Fe-V thin films for high frequency in CMOS compatible microinductors/microtransformers, single layer ferromagnetic Co-Fe-V films have been deposited by radio frequency reactive magnetron sputtering on Si(100) water cooled and/or substrate heating up to 200 °C and heat treated by rapid annealing in high vacuum (2.0×10^{-7} Torr) furnace. $Co_{49}Fe_{49}V_2$ thin films with thickness of about 200 nm exhibited the largest magnetizations (25.7 kG) heretofore observed in similarly produced nanostructured films. Here we present a more detailed study of the microstructures, magnetic properties and high frequency permeability of the nanostructured $Co_{49}Fe_{49}V_2$ films. Also, ferromagnetic resonance (FMR) is used to investigate the change of magnetic phases and magnetic anisotropy field with the substrate temperature and rapid annealing treated. Magnetic

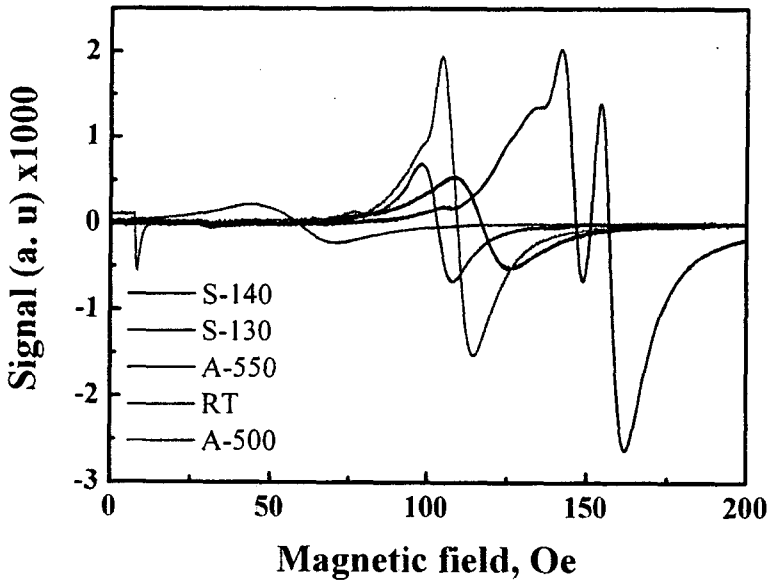

Fig. 1. Ferromagnetic resonance spectra of CoFeV thin films. (RT): water cooled substrate, (S-130): substrate temperature of 130, (S-140): substrate temperature of 140, (A-500): rapid annealing at 500 °C in 5 minutes, (A-550): rapid annealing at 500 °C in 5 minutes.

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hysteresis loops have been measured at room temperature for as-deposited (room temperature and heated substrate) and rapid annealing samples. $Co_{49}Fe_{49}V_2$ films with thickness of 200 nm on Si(100) substrate at room temperature showed large coercive fields of 254 Oe. When similar thickness films were deposited at 150 °C or rapid annealing at about 550 °C, the coercivity dropped to 1.2 Oe and resistivity of about 300 μΩcm. Two phase structure is evident in the hysteresis loops of the films which were fabricated with heated substrate or rapid annealing samples. The results were confirmed by X-ray diffraction (XRD) and transmission electron microscopy (TEM). The CoFeV films were fabricated by RF reactive magnetron sputtering with heated substrate or rapid annealing exhibit the excellent soft magnetic properties. The surface roughness of the sample was measured by atomic force microscopy (AFM). The FMR spectra are obtained at 9.2 GHz as an useful tool for revealing and studying the phase change in thin films as a function of the substrate temperature and rapid annealing process. The effective permeability o these films is 1350, which is remained above 1800 MHz. From ferromagnetic resonance investigation of CoFeV films, it is certain that the magnetic phases change from single phase α-CoFe(110) to mixture of α-CoFe(110) and $(CoFe)_3V$ magnetic phase with increase of the substrate temperature and/or increase rapid annealing temperature, annealing time as shown in Fig. 1.