[S-20]

Iron silicide formation in Fe/Si multilayered films by ion beam mixing

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Recently, Fe/Si multilayered films (MLF) have been a focus of interest due to the strong antiferromagnetic (AF) coupling observed in such kind of MLF. Much consideration has been given to whether the coupling in the Fe/Si MLF originates from the same nature as in the metal/metal MLF. In particular, a question of whether the spacer layer in the Fe/Si MLF is metallic or semiconducting is of interest. Amoung various growth techniques for transition-metal silicides ion-beam mixing (IBM) is known to make smoother surfaces and better electrical properties compared to thermal annealing. In this study, the effect of IBM on the various physical properties of Fe/Si MLF have been investigate. Fe/Si MLFs with varying sublayer thickness have been prepared by RF-sputtering onto glass substrates. The optical and magneto-optical (MO) properties of as-deposited MLF allowed us to conclude that a B2-phase nonmagnetic metallic FeSi compound is spontaneously formed between Fe sublayers during deposition. The ion beam mixing of the Fe/Si MLF has been performed at room temperature by using Ar^{+} ions with an energy of 80 keV, a dose of 1×10^{16} ions/cm^2, and a flux of 1.5×10^{-6} A/cm^2. The structural characterization of Fe/Si MLF after IBM was performed by using low-angle and high-angle x-ray diffraction. The magnetic properties for the Fe/Si MLF were measured at RT by using a vibrating sample magnetometer (VSM) and ferromagnetic resonance spectroscopy (FMR). It was found that the ion-beam treatment has led to noticeable changes in the structural and physical properties of Fe/Si MLF : the formation of a new phase which is characterized by a crystalline silicide structure, the changes in coercivity and Curie temperature. The effect of annealing of the ion-beam mixed Fe/Si MLF was also investigated.