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Effects of post-treatments on the physical properties of Ni/Si multilayered films

김선명[1], 박주상[1], 오차환[1], 이영백[1], Y. V. Kudryavtsev[2], 김기원[3]
[1]한양대학교 물리학과, 양자광기능 물성 연구센터, [2]Institute of Metal Physics, Kiev, Ukraine,
[3]선문대학교 자연과학부

3d transition-metal (TM) Si multilayered films (MLF) are a focus of many investigations due to the peculiar physical properties as well as their technological applicability. This family of MLF is a good candidate for spintronics and so on. In general, 3d TM silicide phases are spontaneously formed in the interfacial region during the MLF deposition. In this study, the silicide formation and the physical properties, including the structural, magnetic, optical and magneto-optical (MO) ones, of Ni/Si MLF with various sublayer thicknesses are elucidated. Ni/Si MLF with a fixed Ni sublayer thickness (3 nm) and variable Si layer thickness (3 - 10 nm) were prepared by rf-sputtering onto glass substrates at room temperature. Since the post-annealing and the ion-beam treatments are usually adopted in device applications, annealed and ion-beam mixed samples are also investigated. Ni/Si MLF are expected to have an enhanced ferromagnetic ordering as the Ni content increases, but all the as-deposited films show nearly non-magnetic behavior, presumably due to the spontaneous silicide formation during the deposition. The actual structure is understood by comparing the experimental MO, optical and magnetic data with the corresponding literature data. The Ni/Si MLF with high and low Si contents reveal different behaviors after the ion-beam mixing or the annealing. The experimental optical-conductivity spectra present that the main peak shifts toward the low-energy side as the Si content increases. The evolution of structure and properties by the post-annealing and the ion-beam treatments is also analyzed and elucidated.