Fabrication of Fe$_3$Si/FeSi$_2$ Multilayers by Facing Targets Direct-Current Sputtering And The Magnetic Properties

SHIN-ICHI HIRAKAWA, KEN-ICHIRO SAKAI, Kyushu University, KAORU TAKEDA, Fukuoka Institute of Technology, TSUYOSHI YOSHITAKE, Kyushu University — Fe-Si system has various phases such as semiconducting $\beta$-FeSi$_2$ and nanocrystalline FeSi$_2$, and ferromagnetic Fe$_3$Si. An Fe$_3$Si/FeSi$_2$ multilayer is a new candidate for a ferromagnet/semiconductor heterostructure in spintronics. In order to accumulate the same kind of materials in atomic scale and form a layered structure with sharp interlaces, the interdiffusion of atoms between the layers should be suppressed. Sputtering methods has been applied for a variety of film preparations. Among them, a facing target direct-current sputtering (FTDCS) method has a merit that a film receives less damage during the deposition since a substrate is placed away from plasma. In this study, we employed the FTDCS method and prepared Fe$_3$Si (25 Å)/FeSi$_2$ (X Å) multilayers, wherein the FeSi$_2$ layer thickness X was changed between 5 and 20 Å. Their structural and magnetic properties were investigated. The X-ray diffraction measurement indicated that the Fe$_3$Si layers are epitaxially grown not only on Si(111) but also up to the top layer across the FeSi$_2$ layers. From the magnetization curves measured at room temperature, it was found that the antiferromagnetic and ferromagnetic interlayer couplings are alternatively induced for a change in the FeSi$_2$ layer thickness X.