# Magnetic Structure Study in $[Fe_3Si/FeSi_2]_{20}$ Superlattices

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Since the discovery of a giant magnetoresistance (GMR) effect associated with an exchange coupling between ferromagnetic layers separated by a nonmagnetic metal spacer, the interlayer coupling has attracted considerable attention from physical and practical viewpoints. The interlayer coupling is described by spin-dependent quantum well states in the spacer. In the case of non-metallic spacers, there often appears a different type of interlayer coupling from that in artificial lattices with metallic spacers. An artificial lattice comprised of Fe-Si materials is one of the representatives. To date, Fe/Si and $Fe/Fe_{1-x}Si_x$ multilayers have been studied. In them, strong antiferromagnetic (AF) interlayer couplings including biquadratic ones, which are different from those in artificial lattices with metallic spacers, are induced. We have conducted research on $Fe_3Si/FeSi_2$ artificial lattices. As compared to the previous artificial lattices based on Fe-Si materials, they have the following advantages: (i) a reduced mismatch in the electrical conductivity; (ii) a strong AF interlayer coupling strength in spite of the saturation magnetization of $Fe_3Si$ being half as that of Fe. In our previous research, we have confirmed that the $Fe_3Si$ layers were epitaxially grown not only on Si(111) but also up to the top layer across the $FeSi_2$ layers and F/AF interlayer couplings were induced by controlling the thickness of the $FeSi_2$ layers. In this study, the interlayer coupling in $[Fe_3Si/FeSi_2]_{20}$ superlattices deposited on Si(111) by facing targets direct-current sputtering (FTDCS) was investigated at low temperatures.

However, the magnetic structures of F/AF interlayer couplings are not clarified. So, we will present magnetic structure which depends on temperature and thickness of semiconductor $FeSi_2$ layer. The polarized neutron reflectivity (PNR) spectrum of the $[Fe_3Si/FeSi_2]_{20}$ superlattices is measured by applying a magnetic field of 1.0 Tesla at Polarized Neutron Reflectometor “SHARAKU” (BL17) in MLF J-PARC. The PNR spectrum reveals the magnetic structures of these superlattices, as shown in Fig. 1. We will indicate the magnetic structure of the superlattice in detail at the conference.

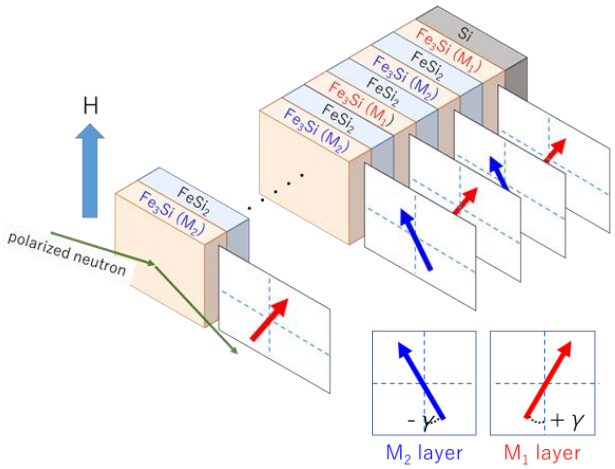


Fig. 1. Proposed magnetic structure of AF interlayer coupling for $[Fe_3Si/FeSi_2]_{20}$ superlattices by PNR measurements.