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The interlayer exchange coupling in $CoFe_2O_4$/Cr/Fe systems

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Since the discovery of the interlayer exchange coupling (IEC) in the magnetic multilayer systems [1,2], conciderable experimental and theoretical studies have been performed. In particular, the oscillation of the IEC as a function of the non-magnetic layers attracted much attention in the spintronics research fields [3].The IEC in the metallic systems, such as Fe/Cr, is explained by the RKKY-like interaction or quantum-well model in the spacer layer [4], however, that in the systems including magnetic insulator is left as unsolved issue. In this paper we investigated the magnetic coupling in $CoFe_2O_4$/Cr/Fe systems.

The samples were grown epitaxially on MgO (100) and (110) substrates by the reactive molecular beam epitaxy method with oxygen radical. The film structures were MgO(100),(110)/NiO(5nm)/$CoFe_2O_4$(30nm)/Cr(t_{Cr}=0-4.2nm)/Fe(5nm)/Al_2O_3(2nm). The NiO layer was inserted to prevent the diffusion of Mg into the $CoFe_2O_4$ layers [5]. $CoFe_2O_4$ layer was deposited by co-deposition of Fe and Co at 300℃ in the oxygen radical atmosphere of 4×10^{-4} Pa. The Cr layers were grown at 130℃, and the Fe and Al_2O_3 layers were deposited at room temperature. The epitaxial growth and the surface morphology were confirmed by RHEED and AFM, and magnetization process was measured by magneto optical Kerr effect (MOKE) at room temperature.

In Figure 1, the saturation fields (H_S) of Fe are plotted as a function of t_{Cr}. For t_{Cr}=0nm, the H_S was enhanced because the Fe layer directly contacts with $CoFe_2O_4$ layer. The H_S decreased with increase of t_{Cr} gradually. For t_{Cr}=4nm, which is considered to be enough to separate the Fe and $CoFe_2O_4$ layer completely, the H_S continued to decrease. It indicated the existence of the IEC, although the orange peel coupling due to the roughness could not be ruled out.

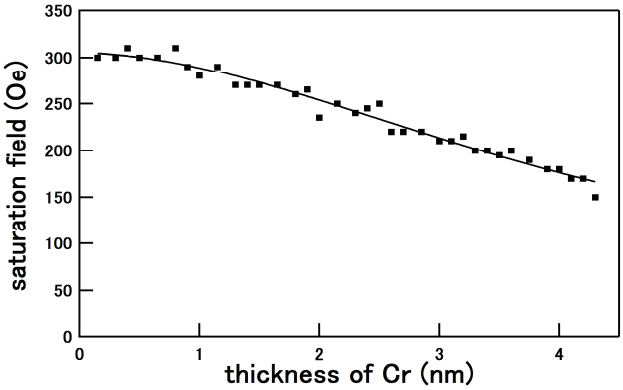

Fig.1 The saturation field of the Fe layer as a function of the Cr thickness

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