Interlayer exchange coupling and proximity effect in V-Fe multilayers

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Two series of V-Fe multilayers (MLs) with either constant Fe (0.6 nm) and variable V sublayer thickness or constant V (1.45 nm) and variable Fe sublayer thickness were prepared by UHV magnetron sputtering. Results on magnetic hysteresis measurements up to 9 T showed that the interlayer exchange coupling (IEC) energy strongly depends on both vanadium and iron layer thicknesses. Furthermore, the strength of the antiferromagnetic (AFM) coupling of the Fe sublayers oscillates with short and long periods as a function of V spacer thickness. The positions of the AFM peaks were also revealed by magnetoresistance measurements. The strongest AFM coupling energy of about 0.84 mJ/m2 at 300 K was observed for V layer thickness equal to 1.45 nm. On the other hand, V/Fe ML with V spacer thickness of about 1.6 nm showed the maximal negative magnetic moment on interface V atoms. The short period of the AFM peak oscillation in the strongly coupled region (below V spacer thickness of about 2 nm) could be explained by a competition between the indirect RKKY coupling of the Fe layers and the direct coupling of the induced negative magnetic moment on V atoms near V-Fe and Fe-V interfaces.