Oscillations of magnetic parameters and giant magnetization of Fe/Be superlattices

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Recently it has been proven experimentally[1] and grounded theoretically[2] that several types of film structures with transition and alkali metals possess enormous magnetic moments of Fe (7 μ_B) and Co (8 μ_B) ions much exceeding the corresponding bulk values. In most cases this is associated with giant orbital contributions to atomic magnetic moment emerging in ions with reduced dimensionality atomic environment. For Fe and Co ions located close to the surface or in bulk alkali, Ag or Au hosts, predominantly surrounded by the host ions, such contributions may amount 2.2–3.0 μ_B[3].

This research consists of comprehensive study of structure, thermal and field dependencies of basic magnetic parameters and of hyperfine fields on ^{57}Fe nuclei from room-temperature Mossbauer absorption spectroscopy within magnetic superlattices (MSL) of Fe with Be spacers synthesized using cathode sputtering in HV-discharge with oscillating electrons. We report two series of MSL: [Fe(10A)/Be(x)] and [Fe(x)/Be(8A)]. The hysteresis loops possess significant in-plane anisotropy relative to the field direction during sputtering. Constricted loop shapes observed at some samples are due to indirect antiferromagnetic exchange between Fe layers dominating at some Be thicknesses that correspond also to maximum positive bias. For [Fe(10A)/Be(x)] series spontaneous and remanent magnetizations as well as coercivity vs. Be thickness x undergo deep oscillations with 6–10A period. The [Fe(x)/Be(8A)] samples show a non-monotonous thickness dependence yet not demonstrating any oscillations in the investigated region. Such behavior is due to oscillations of indirect exchange integral between Fe layers that can be interpreted in the frame of RKKY model.

It is important to stress that in some MSL the J_s values normalized to Fe content run up to several times the corresponding bulk value. Such high magnetization is due to giant orbital contributions in reduced dimensionality local Fe states which has been confirmed by Mossbauer investigation. A substantial role for such states might be played by cluster-like mesoatomic states of Fe ions formed during sputtering[4].

References

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