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Interfacial properties of NiO/Fe/FePt and Fe/NiO/FePt trilayers probed by x-ray and neuron reflectivity

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Different combinations of ferromagnetic (FM) layers and antiferromagnetic (AFM) layers give rise to many exciting effects such as exchange bias [1] and exchange spring [2, 3]. It is well known that these effects are mainly governed by the proximity of FM/FM or FM/AFM or AFM/AFM interfaces. Moreover, different combinations of FM and AFM materials in the form of trilayers allow the co-existence of (a) the exchange spring and exchange bias effect together and (b) simultaneous in-plane and out of plane exchange bias. In this context, we have deposited epitaxial NiO/Fe/FePt and Fe/NiO/FePt trilayers using molecular beam epitaxy (MBE) method and have studied growth, structure and the interface magnetism.

In order to study the interfacial properties of NiO/Fe/FePt and Fe/NiO/FePt trilayers, ex-situ x-ray reflectivity (XRR) and polarised neutron reflectivity (PNR) measurements have been performed. XRR and PNR results indicate that growth of NiO on Fe forms a complex structure of Fe-O at the interface as a result exchange coupling is suppressed between Fe and NiO. On the other hand deposition of Fe layer on NiO layer results in reduced magnetic moment in Fe layer and shows significantly high spin flip reflectivity in PNR measurement. These observations may be attributed to interlayer coupling between Fe and FePt layer. In summary, it was found that interfacial proximity of oxide AFM is chemically reactive. The obtained results are very helpful in tailoring the coupled FM and oxide AFM systems.

1. J. Nogues et al., J. Magn. Magn. Mater. 192, 203 (1999).
2. R. Skomski et al., Phys. Rev. B 48, 15812 (1993).
3. T. Jungwirth et al, Nat. Nanotech. 11, 231 (2016).

Summary

Different combinations of ferromagnetic (FM) layers and antiferromagnetic (AFM) layers give rise to many exciting effects such as exchange bias [1] and exchange spring [2, 3]. It is well known that these effects are mainly governed by the proximity of FM/FM or FM/AFM or AFM/AFM interfaces. In this context we have studied the interfacial properties of NiO/Fe/FePt and Fe/NiO/FePt trilayers using x-ray and polarised neutron reflectivity.

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