Nanocomposites and nanomaterials

Characterization and modification of Fe_3O_4 thin films

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The high energy ion beam techniques can be an effective tool to investigate (Ion Beam Analysis) and to modife (Ion Beam Modification of Materials) thin films. Both IBA and IBMM are widely use in material science.

In our work we are interested in controlling and modeling of interfaces of magnetite thin film systems with optimal structures and desired properties.

A series of single Fe_3O_4/MgO(001) and bilayer Fe_3O_4/Fe/MgO(001) thin films have been prepared by Molecular Beam Epitaxy (MBE) technique. The film chemical composition and layer thickness were determined Rutherford back-scattering (RBS) in three different states: 1) as grown, 2) after a post annealing treatment, and 3) after 1MeV Kr^+ or Ar^+ irradiation with different ion fluence. For the RBS data evaluation, the simulation program SIMNRA was used. To determine the absolute values of the film- thickness and film- density independly from the RBS measurements, x-ray reflectometry (XRR) measurements have been performed. To check the film crystallinity, the RBS channeling (RBS-C) experiments were performed on several films.

Our analysis of ion beam modifications indicates that ion irradiation induced a very large ion mixing effect leading to a formation of a large interface zone having a spinel and/or wustite formula. The most important findings of our investigations is that pure magnetite layer in the bi-layer films was well preserved upon an ion irradiation with small doses. It indicates a high stability of the stoichiometric Fe_3O_4 layer of the magnetite-on-Fe films.