Epitaxial growth of Fe_3O_4 on ZnO nanostructures

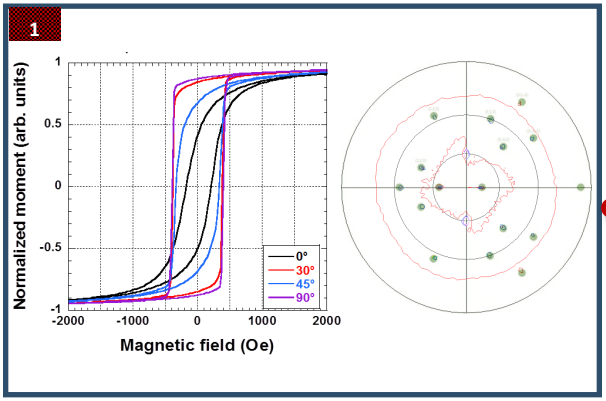

Fig 1: in-plane magnetization loops (rt) and XRD pole figure of a 150 nm-thick Fe_3O_4 epilayer grown on m-plane nonpolar ZnO. The pole figure taken at 2Θ = 57° shows the (5,1,1) and (3,3,3) reflections of only one single Fe_3O_4 domain oriented along the (1-12) direction.

Single-domain growth of ferrimagnetic Fe_3O_4 on nonpolar ZnO

There is currently a worldwide effort to integrate semiconductors and magnetic materials, as an efficient spin injection and detection of spin in semiconductors is essential to the field of spintronics, but remains an unsolved issue.

The research project "SPINOXIDE" aims at taking advantage of both ZnO compatibility for the epitaxy of highly spin-polarized oxide ferromagnets and the potentially exceptional spin coherence lengths and spin lifetimes in ZnO nanostructures.

Convincing preliminary results (see figure) have been obtained regarding the growth of the semi-metal Fe_3O_4 (magnetite, T_C =860K) for which a spin-polarization of 100% is expected.

High-quality Fe_3O_4 epilayers have been grown both on polar c- and, for the first time, nonpolar m-ZnO showing the importance of the stoichiometry control of the first 1-2 ML and even the orientation of atomic steps on the ZnO surface.

Breakthroughs

- Tuning of the stochiometry at the interface to tailor structural and magnetic isotropy and band offsets.

- Single-domain growth on nonpolar ZnO either in the (111) or (1-12) Fe_3O_4 orientations.

Perspectives

Efficient spin injection(and detection) in ZnO nanostructures owing to 100% spin-polarization in Fe_3O_4 and interface control

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