Epitaxial iron oxide nanoislands on $SrTiO_3$ – Structure, Arrangement and Magnetism

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Magnetite (Fe_3O_4) nanostructures such as thin films, nanoparticles and nanoparticle assemblies have applications in medicine, material science, catalysis and as a basis for magneto-electric devices [1,2,3,4].

Compared with bulk materials, the magnetic properties of magnetite nanostructures differ significantly due to size effects like shape anisotropy and superparamagnetism. Additionally, the growth procedure and oxidation/reduction reactions cause defects such as magnetically unordered surface structures and antiphase boundaries [5]. Iron oxide nanoislands grown on (001) oriented $SrTiO_3$ by reactive molecular beam epitaxy could serve as a model system to study these effects. The large lattice mismatch between $SrTiO_3$ facilitates the growth of separated nanoislands while the interaction with $SrTiO_3$ further modifies the chemical, magnetic and electronic properties of the iron oxide nanostructures [6]. We present the characterisation of iron oxide nanostructures on $SrTiO_3$ by grazing incidence small angle scattering (GISAXS, Fig. 1), reflection high energy electron diffraction (RHEED, Fig. 1, inset), surface X-ray diffraction and SQUID magnetometry suggesting the growth of ferrimagnetic crystalline square shaped Fe_3O_4 islands oriented along the $SrTiO_3$ (110) directions.

Due to their ordered arrangement and well-defined structure, the islands constitute a simplified model system for further studies of the magnetic properties of nanostructured Fe_3O_4.

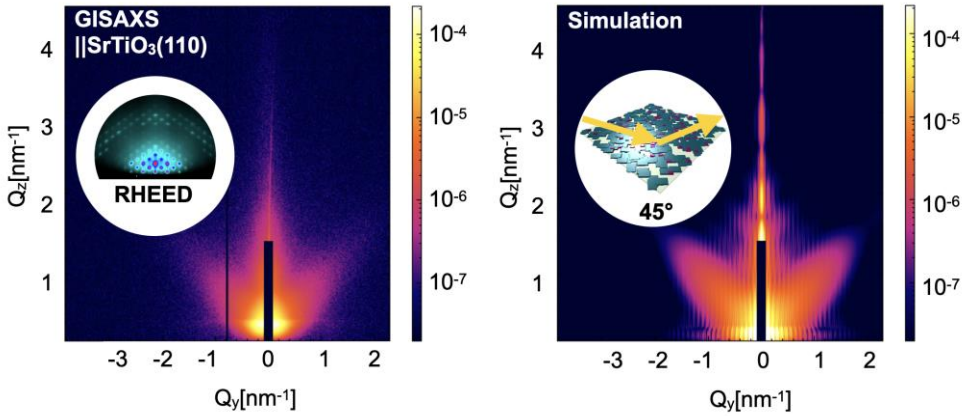

Fig. 1 GISAXS image (left) and simulation (right) of the nanoislands. While RHEED shows the crystallinity of the iron oxide islands (left inset), GISAXS suggests facet ordering along the $SrTiO_3$ (110) direction as in the model used for the simulation (right inset).

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