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Diffusion of iron in the near-surface region of magnetite (001)

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The mobility of Fe in magnetite is a key ingredient towards a better understanding of its defect structure and resulting properties. For nanoparticles, which find a range of applications in medicine, spintronics, material science and catalysis, the near-surface is particularly important. Recent scanning tunnelling microscopy (STM) and low energy electron diffraction (LEED) studies of the $(\sqrt{2}\times\sqrt{2})$R45° reconstructed (001) surface suggested a subsurface vacancy stabilisation model for this surface, later proved by surface x-ray diffraction (SXRD) [1,2]. Low energy electron microscopy (LEEM) experiments under catalytic conditions showed a regrowth process of Fe_3O_4-layers on (001) surfaces [3]. These results point towards an interesting interplay between cation vacancy formation and diffusion.

We present the results of iron exchange at the interface between $^{57}Fe_3O_4$ thin-films and a Fe_3O_4 (001) substrate after ultra high vacuum annealing at multiple temperatures. By exploiting the scattering length variation of ^{57}Fe and natural Fe, its interdiffusion across the film-substrate interface is characterized by neutron reflectometry at MARIA at MLZ [4].
The results on growth and diffusion are complemented by x-ray reflectometry data.

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