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Metamagnetic transition in nanosized FeRh structures. Nanoscale iron-rhodium islands with a range of lateral dimensions were successfully fabricated on MgO substrates using masked molecular beam epitaxy. Nanofocused synchrotron-based nuclear resonant scattering was employed to spatially resolve individual islands and to perform in-situ measurements of their magnetic states and metamagnetic phase transitions (Fig. 1). The results reveal a strong size dependence of the metamagnetic behaviour of FeRh: as the island size decreases, the phase transition progressively shifts and weakens ultimately vanishing below a critical size threshold. This suppression indicates that finite-size effects play a decisive role in governing the magnetic properties of FeRh at the nanoscale. The observed behaviour is attributed to nanoscale-specific factors such as the increased surface-to-volume ratio, modified atomic coordination and oxidation-related effects [1].

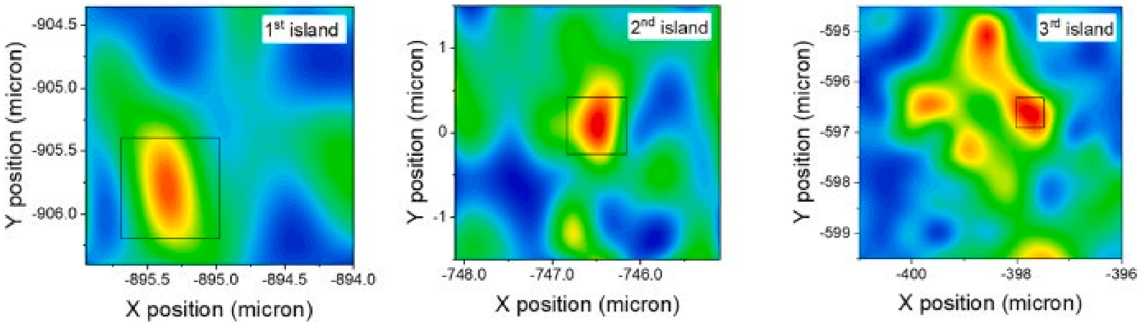

Figure 1. The topological images of the investigated areas were obtained through a 2D scan of the nanobeam. The rectangle indicates the beam size and the positions where the temperature dependent NRS measurements were conducted. The colour map displays the detected delayed photons at each position, reflecting the amount of FeRh present at each point.

Surface characteristics of ferromagnetic phase nuclei in the $Fe_{48}Rh_{52}$ alloy. Materials exhibiting first-order magnetic phase transitions undergo dramatic changes in their physical properties in the vicinity of the transition temperature, yet the underlying mechanisms governing these transitions remain incompletely understood. In this work, the near-surface magnetic and structural behaviour of the $Fe_{48}Rh_{52}$ alloy in the vicinity of its phase transition was investigated. Temperature-dependent magneto-optical Kerr effect imaging was used to analyse the evolution of magnetic domains, enabling us to distinguish between the roles of ferromagnetic phase nucleation and subsequent domain growth during the transition. High-resolution transmission electron microscopy (HRTEM) results (Fig. 2) showed that the crystal lattice in the near-surface region may undergo slight tetragonal distortion leading to uniaxial anisotropy close to the surface. This distortion arises from a deviation of the lattice parameter along the surface-normal direction (c) from those of the in-plane axes ($a = b$). Simultaneous analysis of measurements of the magnetocaloric effect and magnetostriction along different directions showed that, during the field-induced phase transition, the growth rate of the ferromagnetic phase was higher along the direction of the applied external magnetic field than in the perpendicular direction. By fitting the experimental observations with a proposed theoretical model, the surface energy of ferromagnetic clusters with different micromagnetic configurations was estimated. The results demonstrate how microscopic magnetic and structural features influence the emergence of the alloy's macroscopic properties [2].

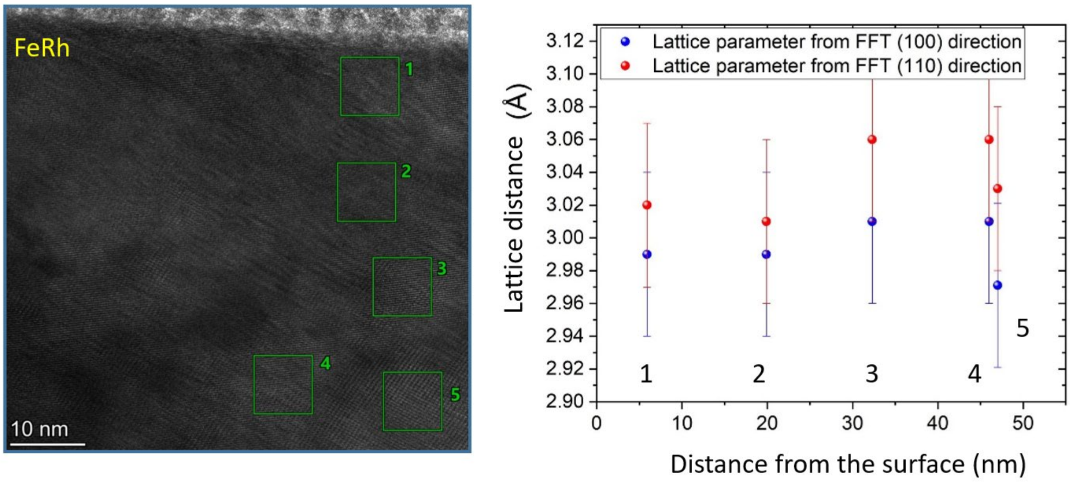

Figure 2. HRTEM image recorded on B2 FeRh phase of the sample (left) and the calculated lattice parameters from the fast Fourier transformation (FFT) of the selected areas as a function of distance from the surface are shown in the right.

Stable isotope targets prepared by ion implantation. Alpha-induced reactions play a particularly important role in the astrophysical weak r-process, which synthesizes the neutron-rich isotopes between strontium and silver. The accuracy of the nucleosynthesis simulations is strongly influenced by the reliability of the nuclear physics input parameters used. Recently, it has been demonstrated that (α,n) reactions play a particularly important role in the weak r-process, but their rates computed from the cross sections are only known with large uncertainties in the astrophysically relevant energy range. To determine the cross section of a given reaction a well-characterized target is needed. One of the possibilities to produce such targets is the ion-implantation method. Recently, targets have been prepared by implanting ^{86}Kr isotopes into a high-purity aluminium foil and used to determine cross sections relevant to the weak r-process [3, 4].

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