Magnetic properties of FeRh nanostructures

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The control of a magnetic state by thermal or electrical activation is essential for the development of new magnetic devices, for instance in heat or electrically-assisted magnetic recording or room-temperature memory resistor [1-3]. FeRh is expected for such applications: it presents an unusual magnetic transition from a low temperature antiferromagnetic state to a high temperature ferromagnetic state close to 370K accompanied by a 1% volume expansion [4-5]. The transition is obtained for a narrow composition range $0.48<x<0.56$ in the B2-ordered α' crystal phase of $Fe_{1-x}Rh_x$.

While the FM-AFM transition is sharp in the bulk alloy, the persistence of a FM component at low temperature in FeRh thin films raised important questions about the effect of size reduction, interfaces and surface termination on their magnetic properties. In addition, the mechanisms involved in the transition are still under debate as they were mainly studied with surface investigation techniques without visualization of the magnetic reorganization in volume. We have combined advanced TEM investigations and first-principle calculations on FeRh nanoparticules and thin films for a deeper understanding of the properties of this alloy.

Using aberration-corrected (scanning) transmission electron microscopy, magnetometry experiments and theoretical calculations, we will show that the surface configuration can stabilize a low temperature ferromagnetic (FM) state in FeRh nanoparticles in the 6–10 nm range [7] synthetized by magnetron sputtering. In addition, *in situ* electron holography performed on epitaxial FeRh thin film in a cross-sectional view demonstrates the effects of discontinuities and defects on the magnetic transition at the nanometer scale [8]. An unexpected transition mechanism with first the appearance of a periodic spacing of nucleated ferromagnetic domains followed by a spatial extension during transition monitoring has been evidenced.

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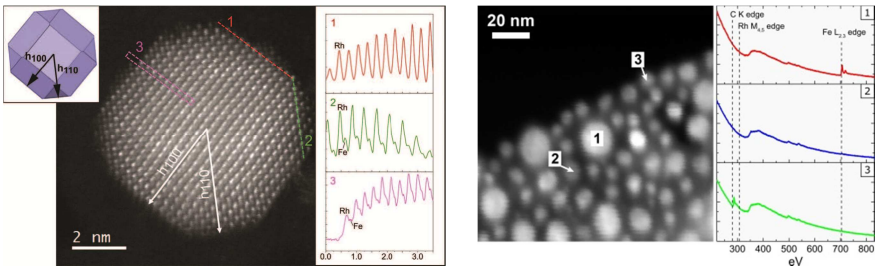

Figure 1: (left) HAADF-STEM image of a NP observed along the [001] direction of B2-FeRh. (right) EELS analyses of particles deposited by co-sputtering of Fe ad Rh targets).