ABSTRACT CODE

Resonant Magnetic X-ray diffraction study of the $UP_{1-x}S_x$ system

V.H. Rodrigues[1], J.A. Paixão[1], M.M.R.R. Costa[1], G.H. Lander[2], D. Mannix[3], O. Vogt[4]

[1] *CEMDRX, Departamento de Física, Fac. Ciências e Tecnologia, Universidade de Coimbra, P-3004-516 Coimbra, Portugal*
[2] *European Institute for Transuranium Elements, Postfach 2340, D-76125 Karlsruhe, Germany*
[3] *European Synchrotron Radiation Facility (XMaS CRG), BP 220, F-38043 Grenoble, France*
[4] *Laboratory for Solid State Physics, ETH, CH-8093 Zürich, Switzerland*

The NaCl-type $UP_{1-x}S_x$ solid solutions exhibit a complex magnetic behaviour which has been studied by several techniques, including neutron diffraction [1,2]. The phase diagram depicted in fig. 1 shows a number of magnetic phases, commensurate and incommensurate of single- and multi-**k** character. The magnitude of the propagation vector **k** decreases with x until it becomes zero at x = 0.3, when the samples become ferromagnetic. This behaviour, which is also present in other actinide monopnictide-monochalcogenide solid solutions (eg. UAs-USe), can be understood as a result of the filling of the conduction band states, near the Fermi level. These compounds show a tendency to stabilize multi-**k** structures at low temperature and a considerable theoretical effort has been undertaken to understand this property [3]. In the $UP_{1-x}S_x$ system a double **k** type IA (+ + − −) low temperature phase was suggested, but the multi-**k** nature of the magnetic structure had not yet been confirmed by experiment.

Our work was performed at the magnetic diffraction beamline XMaS (BM28) at the ESRF, Grenoble. A resonant magnetic x-ray diffraction experiment was carried out on a single-crystal sample with composition $UP_{0.8}S_{0.2}$ with incident energy tuned to the U M_{IV} edge (3.729 keV). A detailed study of the sequence of magnetic phase transitions was possible due to the high resolution of the technique.

Recently, resonant magnetic x-scattering was shown to be able to distinguish between single and multi-**k** structures in zero-field [4]. Multi-**k** structures generate, on resonance, a new set of intermodulation reflections of the form $\mathbf{k}_i+\mathbf{k}_j$ that have a different energy dependence from the main magnetic reflections. The presence of such Bragg reflections in the low temperature IA phase is an unambiguous signature of the multi-**k** nature of the magnetic structure. These intermodulation reflections were not observed in the 3+3− and incommensurate phases which imply that they are probably single-**k**.

The two Fourier components of the intermediate 3+3− phase were measured in the resonant regime, their intensities fit the ratio expected for a square wave. Above 75 K and up to the Néel temperature several incommensurate magnetic peaks are observed and cohexist with the 3+3− structure in a narrow temperature interval. It was found that the stability range of the incomensurate phases depend on the sample thermal history (fig. 2). This histeretic behaviour was carefully characterized in the experiment.

In complement to the measurements performed on resonance at the U M_{IV} absorption edge, high energy photons (8 keV) were also used to study the lattice behaviour, i.e. the magnetoelastic effects. Reflections of the form (00L), characteristic of an internal distortion of the lattice due to a small displacement of the atoms were found in the low temperature IA magnetic phase and in the narrow temperature range between 75 and 83 K of the incommensurate phase (fig. 3).

Further experiments are planned to complement this study.

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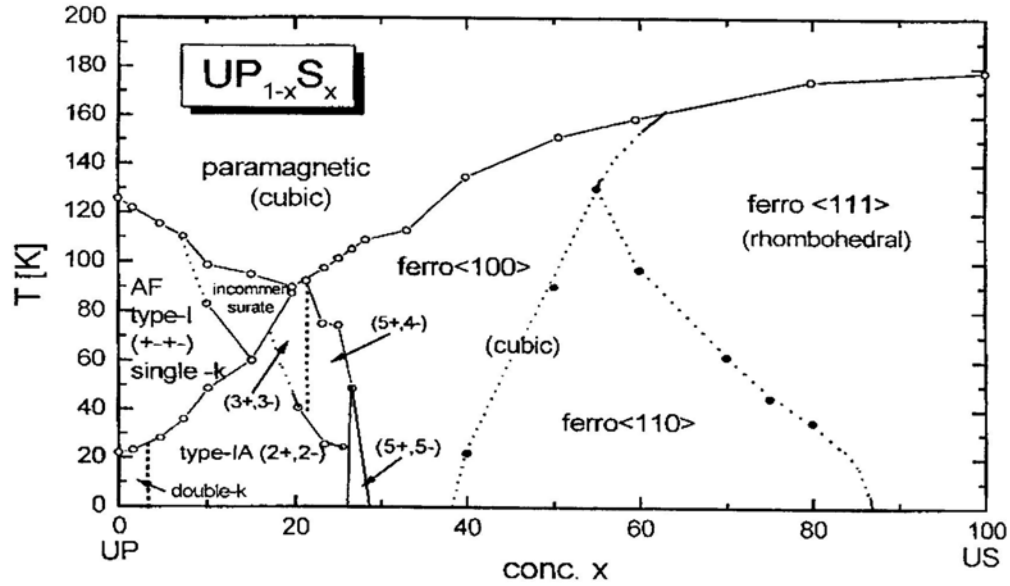
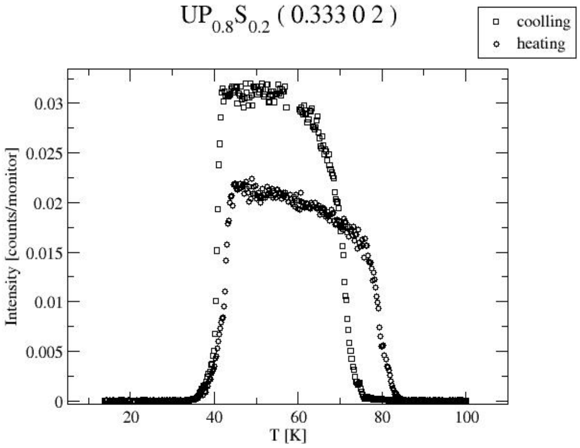


Fig. 1. UP_{1-x} S_x magnetic phase diagram [2].



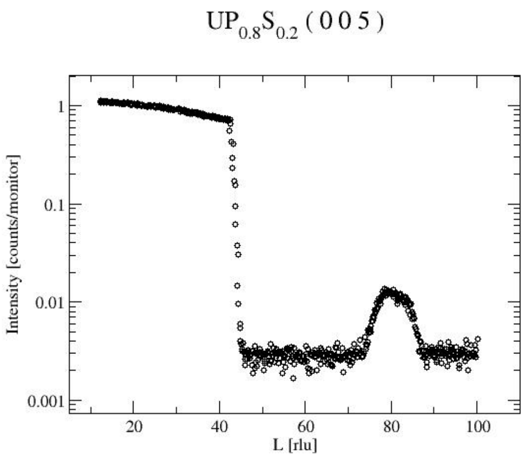


Fig. 2. Intensity of the (1/3 0 2) reflection, characteristic of the 3+3- phase, as a function of temperature. Notice the hysteresis in the temperature range of coexistence with the incommensurate phases.

Fig. 3. Intensity of the (005) reflection measured at 8 keV as function of temperature plotted in a logarithmic vertical scale.

References

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