Further RXMS Studies of the Pu$_x$U$_{1-x}$Sb Series
P. Normile, W. Stirling (Liverpool U., U.K.), D. Mannix and G. Lander (EITU, Germany)
Abstract No.: norm6908
Beamline(s): X22C

Introduction: Following on from our first (successful) resonant x-ray magnetic scattering (RXMS) study of Pu-containing samples, made on Pu$_x$U$_{1-x}$Sb for $x = 1.00$ and 0.75 (Normile et al, 1999), measurements have been on a crystal of lower Pu concentration, $x = 0.5$. One of the main motivations for this work was to investigate the resonance at the plutonium M$_5$ edge, since this was found to be "split" in $x = 0.75$.

Methods and Materials: Measurements were made on a single-crystal sample of Pu$_{0.5}$U$_{0.5}$Sb which was mounted using indium solder and encapsulated in Be - both as in the previous study ($x = 1.00$ and 0.75).

Pu$_x$U$_{1-x}$Sb crystallizes in the NaCl structure and $x \leq 0.5$ exhibit type I ($k = 1$) magnetic ordering (Normile et al, 1998) (isostructural with USb). Magnetic scattering from $x = 0.5$ was thus searched for at the (003) position.

Results: An identical splitting to that found in $x = 0.75$ (≈ 10eV) is measured in Pu$_{0.5}$U$_{0.5}$Sb – this is shown by the inset of Fig.1. The data of Fig. 1 includes the U M$_5$ resonance, which, unlike the Pu M$_5$, is clearly a single peak. Our previous study ($x = 0.75$) could not obtain a measurement of the U M$_5$ resonance due to poor incident flux at this energy. The present study thus allows us to obtain branching ratios for both U and Pu.

Conclusions: Pu M$_5$ splitting is a feature of the Pu$_x$U$_{1-x}$Sb series. An explanation for this effect is lacking but could reside in a hybridization of the 5f, $j = 7/2$ states of Pu with the Sb 5p states. Alternatively, dichroism measurements made on U compounds (Dalmas de Réotier et al, 1999), which have shown a double lobe structure at the U M$_5$ edge, may provide us with a key to understanding the splitting of the Pu M$_5$ resonance. Splitting has never been observed at the U M$_5$ edge in any RXMS experiment. The reason for this could be the strong interference of the (tails of the) U M$_4$ resonance with the U M$_5$.

Acknowledgments: Work supported by EPSRC and EITU.


Figure 1. Peak intensity of the (003) magnetic reflection from Pu$_{0.5}$U$_{0.5}$Sb as a function of the incident x-ray energy. The solid line is a fit to the standard dipole oscillator model (see, for example, McWhan et al, 1999).