



	Experiment title: Synchrotron Magnetic Scattering from Actinide Materials	Experiment number: HE 1828
Beamline: ID20	Date of experiment: from: 15/09/2004 to: 21/09/2004	Date of report: 17/01/2005
Shifts: 18	Local contact(s): Dr. S. B. Wilkins	<i>Received at ESRF:</i>

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Report:

During the period 15–21 Sept. 04 experiments were run on a number of transuranium samples at the ID20 beamline.

Initially capsule #27 containing $(U_{1-x}Np_x)O_2$, $x=0.45$, 0.75 was examined. Both crystals were found, i.e. their lattice peaks observed, but no magnetic scattering could be found either at the $q = [001]$ or $[1/2 \ 1/2 \ 1/2]$ wave vectors. The situation with respect to the $x=0.45$ sample is that this has not been examined before but with $x=0.50$ it has been reported from neutron experiments [1] that diffuse scattering exists below $T_N = 12$ K close to the position corresponding to the wave vector $(1/2 \ 1/2 \ 1/2)$. With the $x=0.75$ sample a similar situation was reported from neutrons [2], again on a polycrystalline sample with $T_N = 10.5$ K. This was the first time that a transuranium sample was cooled below 10 K and this aspect of the experiment went well. The absence of any observable magnetic scattering could be due to many reasons, the most likely being either that the scattering is too diffuse (corresponding to short-range order) to be picked up by the excellent resolution of ID20, or that the magnetic wave vector is not along the $[1/2 \ 1/2 \ 1/2]$ direction. In this respect it is unfortunate that the $x=0.45$ sample prepared for the neutron Laue apparatus has not been able to be examined because of security concerns at the ILL. If this had been run this ESRF experiment might have been successful.

After this failure capsule #31 was examined with two samples $(U_{1-x}Pu_x)O_2$, $x= 0.05$, 0.95. In this case the lattice peaks were again found easily, but (again) no sign of magnetic scattering. In the case of the $x=0.05$

sample we know that the $T_N = 29$ K, which is only a very small reduction from UO_2 with $T_N = 30$ K. It was therefore expected that the ordering wave vector would be $q = [001]$ as in UO_2 . Apparently, this is not the case*. This is very surprising as Pu is supposed to be in a singlet ground state in the oxides, and thus have no magnetic moment, and only a small effect on the magnetic interactions. Already Kolberg *et al.* [3] have challenged this simple idea, and our experiments have added further questions, without resolving the matter.

The lesson of these experiments is that perhaps it is important to insist on neutron experiments as a prerequisite for using the more sophisticated technique of RXS.

*Both crystals were examined in case the concentration was mixed up, but no magnetic scattering was found in the second crystal either. The $x=0.95$ sample does not order [3].

[1] A. Tabuteau et al, J. Phys. Lett. **45**, (1984) L373

[2] A. Boeuf et al., Europhysics Lett. **3** (1987) 221

[3] D. Kolberg et al., Phys. Rev. B **66** (2002) 214418