ESRF	**Experiment title:** An Investigation of phase segregation in RuSr2Gd0.9Y0.2Cu2O10	**Experiment number**: HS-4014
Beamline:	**Date of experiment**: from: 07/07/2010 to: 08/07/2010	**Date of report**: 28/02/2011
Shifts: 3	**Local contact(s)**: Adrian Hill	*Received at ESRF:*

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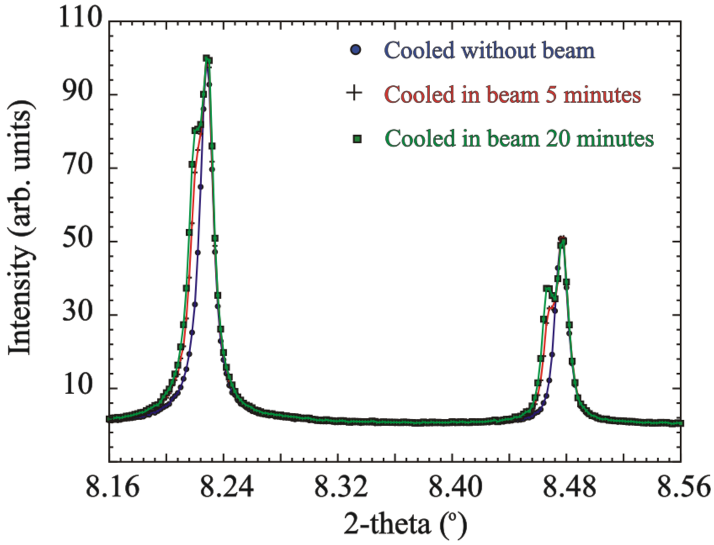
Report:

We have recently synthesised new ruthenocuprates $RuSr_2Nd_{1.8-x}Ce_xY_{0.2}Cu_2O_{10}$; these materials are extraordinary. Superconductivity is observed in the CuO_2 planes for x = 0.6 (T_c = 20 K). However giant magnetoresistance (GMR) is observed for $RuSr_2Nd_{1.1-x}Ce_{0.9}Y_xCu_2O_{10}$ [1]; a maximum value of -47% has now been observed for $Ru_{0.8}Ta_{0.2}Sr_2Nd_{1.0}Y_{0.1}Ce_{0.9}Cu_2O_{10}$ in a 7 Tesla field at 4 K [2]. This is the first time that bulk negative colossal magnetoresistance has been observed in an underdoped cuprate material. In order to further investigate the large negative magnetoresistances observed in $RuSr_2Nd_{0.9}Y_{0.2}Ce_{0.9}Cu_2O_{10}$ a series of materials $RuSr_2RE_{1.1-x}Y_xCe_{0.9}Cu_2O_{10}$ (RE = Nd, Sm, Eu, Gd) were synthesized. The magnetotransport results show an unusual crossover from negative to positive magnetoresistance as the rare earth size decreases. The magnetoresistance increases linearly from -34% to 11% as <R> decreases from 1.042 Å to 1.012 Å. Positive magnetoresistance is observed for $RuSr_2RE_{0.9}Y_{0.2}Ce_{0.9}Cu_2O_{10}$ (RE = Eu and Gd, <R> = 1.018 Å and 1.012 Å respectively) [3]. Hence the magnetotransport properties of the 1222 ruthenocuprates are extremely sensitive to size. In a previous experiment on beamline ID31 (HS-3215) we showed that the crossover from negative to positive resistance with decreasing <R> is not due to a change in crystal structure. Surprisingly upon cooling $RuSr_2Gd_{0.9}Y_{0.2}Ce_{0.9}Cu_2O_{10}$ in the beam to 5 K, a new phase with larger cell volume is observed. As time increases the percentage of the new “large volume” phase also increases (Fig. 1). The phase segregation disappears upon warming the sample back to 150 K and was not present if the sample was cooled to 5 K without the beam on. Similar photo-induced phase segregation has been observed in the CMR manganites as a result of strong electron lattice interactions [4, 5]. The aim of the experiment was to further study the photoinduced phase segregation (PS) and to discover if the observed PS coincides with one of the several magnetic or electronic transitions observed in $RuSr_2Gd_{0.9}Y_{0.2}Ce_{0.9}Cu_2O_{10}$ [1-3].

Figure 1. Portions of the normalised synchrotron X-ray diffraction patterns of $RuSr_2Gd_{0.9}Y_{0.2}Ce_{0.9}Cu_2O_{10}$ recorded at 5 K demonstrating that phase segregation is only observed when the sample is cooled in the beam.



Unfortunately the same results could not be reproduced and there was no evidence of photoinduced phase segregation. The experiment was repeated on three different samples, using the same conditions in which the phase segregation had previously been detected. This suggests that the observed phase segregation was a result of inhomogeneous sample heating.

References

1. A. C. Mclaughlin, F. Sher and J. P. Attfield, *Nature* (London) **436**, 829 (2005).
2. A. C. Mclaughlin, L. Begg, A. J. McCue, F. Sher and J. P. Attfield, *Chem. Commun* 2273 (2007).
3. A. C. Mclaughlin, L. Begg, C. Harrow, S. A. J. Kimber, F. Sher and J. P. Attfield, *J. Am. Chem. Soc.*, **128**, 12364 (2006).
4. Y. Kiryukhin *et al*, *Nature*, **813**, 386 (1997).
5. D. E. Cox, P. G. Radaelli, M. Marezio and S-W. Chong, *Phys. Rev.B* **57**, 3305 (1998).