ESRF	**Experiment title:** **Strong enhancement of the multiferroic parameters in the iron-containing langasite crystals under high pressures**	**Experiment number:** **MA-2394**
Beamline: **ID18**	**Date of experiment**: from: 12 November 2014 to: 18 November 2014	**Date of report**: 28/02/2018
Shifts: 18	**Local contact(s)**: R. Rueffer A. Chumakov	*Received at ESRF:*

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Report:

The new method of synchrotron Mossbauer spectroscopy made it possible to perform very fine high pressure experiments at low temperatures with the iron-containing langasite family crystals which are now considered as a new class of promising multiferroics. The high pressure properties of a new multiferroic of the langasite family $Ba_3TaFe_3Si_2O_{14}$ were investigated in diamond-anvil cells (DAC) in the temperature range of 4.2–295 K by a new method of synchrotron Mossbauer spectroscopy. The measurements were performed at the Nuclear Resonance beamline ID18 at the European Synchrotron Radiation Facility (ESRF) in Grenoble, France. Mössbauer spectra for $Ba_3TaFe_3Si_2O_{14}$ were measured using Synchrotron Mössbauer Source (SMS). The high pressures up to 30 GPa were created in DACs, and helium was used as the best quasihydrostatic pressure-transmitting medium.

Strong enhancement of the Neel temperature T_N was observed at pressures above 20 GPa associated with the structural transformation. The highest value of T_N is about 130 K which is almost five times larger than the value at ambient pressure (about 27 K). Strong enhancement of the Neel temperature T_N revealed at high pressures is obviously associated with the structural transition at 20 GPa observed previously in our XRD studies. It was suggested that the high value of T_N appears due to redistribution of Fe ions over 3*f* and 2*d* tetrahedral sites of the langasite structure. In this case, the short Fe-O distances and favorable Fe-O-Fe bond angles create conditions for strong superexchange interactions between iron ions, and effective two-dimensional (2D) magnetic ordering appears in the (*ab*) plane. The separation of the sample into two magnetic phases with different T_N values of about 50 and 130 K was revealed, which can be explained by the strong two dimensional 2D magnetic ordering in the (*ab*) plane and 3D ordering involving inter-plane interaction.

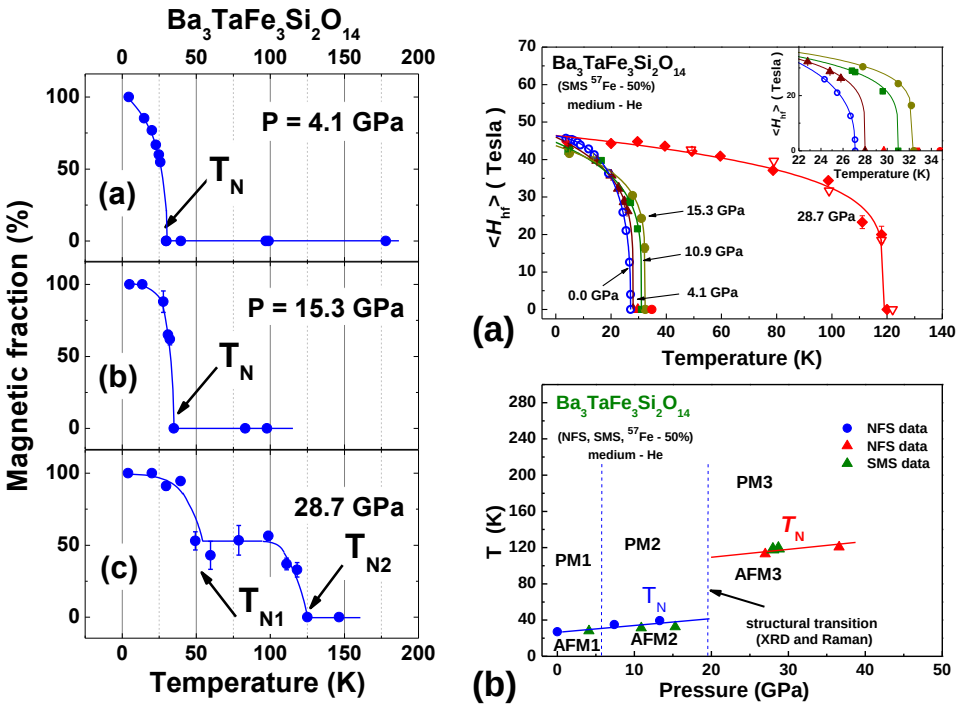

Figure 1. Temperature dependences of areas of magnetic (blue points) components in the Mössbauer spectra of $Ba_3TaFe_3Si_2O_{14}$ at different pressures below and above the structural transition at P =20 GPa

Figure 2. (a) Temperature dependences of the average values of magnetic hyperfine field $<H_{hf}>$ at iron nuclei in the magnetic fraction of langasite $Ba_3TaFe_3Si_2O_{14}$ estimated from Mössbauer spectra at different pressures before and after the structural transition at 20 GPa. Inset shows the $<H_{hf}>$(T) dependences at P < 20 GPa in an enlarge scale; (b) is the magnetic P-T phase diagram of langasite $Ba_3TaFe_3Si_2O_{14}$.

The results were published in:

1. I. S. Lyubutin, S. S. Starchikov, A. G. Gavriliuk, I. A. Troyan, Yu. A. Nikiforova, A. G. Ivanova, A.I. Chumakov, R. Rüffer, "Magnetic phase separation and strong enhancement of the Neel temperature at high pressures in a new multiferroic $Ba_3TaFe_3Si_2O_{14}$",
JETP Lett. **105** #1 (2017) 26-33.
DOI: 10.1134/S0021364017010027

The results were used in the reports:

1. Lyubutin I.S. "Magnetism at high pressures" (**Plenary Lecture**).
Moscow International Symposium on Magnetism (MISM-2017), 1-5 July 2017, Lomonosov Moscow State University, Moscow, Russia. Book of Abstracts p. 951.
https://mism.magn.ru

2. I.S. Lyubutin, "Erika Bauminger's magnetism supertransferred to superconductivity and biomedicine of nowadays", (**Plenary Lecture**), The 3rd Mediterranean Conference on the Applications of Mössbauer Effect (MECAME-2017) Jerusalem, Israel, 04 – 07, June 2017, Book of Abstracts, p. 1-2.
http://mecame2017.irb.hr/