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The manifestation of magnetic properties on proton irradiated langasite structure

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We have investigated the manifestation of magnetic properties on proton irradiated langasite $\text{Ba}_3\text{NbFe}_3\text{Si}_2\text{O}_{14}$ material. The solid state reaction method was used to prepare the sample and 5 MeV proton beam was irradiated with 0, 10 $\text{pC}/\mu\text{m}^2$.

X-ray diffraction patterns were refined by Rietveld method with FULLPROF computer program. The results show that the crystal structure is non centrosymmetric trigonal structure with space group of $P321$ [1] and the lattice constants $a_0 = 8.522$ and $c_0 = 5.243$ Å for non-proton irradiated sample and $a_0 = 8.527$ and $c_0 = 5.246$ Å for 10 $\text{pC}/\mu\text{m}^2$ proton irradiated sample. From the results of superconducting quantum interference device magnetometer (SQUID), both samples show the antiferromagnetic ordering with $T_N = 27$ K. Figure 1 shows the increase of moment with proton irradiation. Also, compared to non-irradiated sample, which has the the coercivity (H_c) of 1647 Oe at 5 K, the value of coercivity at 5 K is 2080 Oe for 10 $\text{pC}/\mu\text{m}^2$ irradiated sample. The Mössbauer spectra were taken at temperature ranging from 4.2 K to room temperature. It shows that the doublet characteristic of the paramagnetic phase at 27 K, which consistent with SQUID results. From the isomer shift (δ) value = 0.22 mm/s for the sample at 4.2 K, iron ion state is determined to be 3+ state with 5/2 spin state. These results suggest that the magnetic properties of $\text{Ba}_3\text{NbFe}_3\text{Si}_2\text{O}_{14}$ sample was affected by proton irradiation.

[1] K. Marty, V. Simonet, E. Ressouche, R. Ballou, P. Lejay, and P. Bordet, *Phys. Rev. Lett.*, **101**, 247201 (2008).

