"Spatially modulated spin ordering in
compounds with a langasite type crystal structure: 57Fe Mossbauer reinvestigation"

Langasite family compounds based on the $La_3Ga_5SiO_{14}$ mineral attract high interest that mainly caused by their multiferroic properties that are closely related to the unusual magnetic structure of these compounds. The Type-II multiferroic langasite-like $Ba_3SbFe_3Si_2O_{14}$ oxide has a noncollinear magnetic structure with a magnetic ordering temperature T_N ~ 34K. The magnetic helix structure of $Ba_3SbFe_3Si_2O_{14}$ below T_N is a result of competing antiferromagnetic intralayer and interlayer interactions.

The present work reports new analysis and reinterpretation of the ^{57}Fe Mössbauer data [1] for the ferrite $Ba_3SbFe_3Si_2O_{14}$ with langasite-like crystal structure. The sample enriched with ^{57}Fe isotopes was obtained by the solid-phase synthesis method. The stoichiometric amounts of pre-dried $BaCO_3$, Fe_2O_3, Sb_2O_5, SiO_2 were used as precursors. The annealing was carried out at two stages: at 1000° C and 1225° C for 24 hours.

^{57}Fe Mössbauer spectra recorded above $T_N \approx 34$ K consist of a quadrupole doublet with a high quadrupole splitting ($\Delta_{35K} \approx 1.32$ mm/s) underlying distorted local surrounding of the unique Fe^{3+} sites. The self-consistent calculations of the lattice contribution to the electric field gradient (EFG) at ^{57}Fe nuclei have show a significant dipole contribution to the EFG with the oxygen polarizability of $\alpha_O \approx 0.4$ Å^3. In the temperature range $T < T_N$, Mössbauer spectra are consistent with a modulated helical magnetic order, where iron magnetic moments rotate within the (*ab*) plane with propagation vector along *c* axis. All experimental spectra at $T < T_N$ were analyzed assuming the modulation of the electric hyperfine interactions and the anisotropy of the magnetic hyperfine field H_{hf} at the ^{57}Fe nuclei when the Fe^{3+} magnetic moment rotates with respect to the principal axis of the EFG tensor. The anisotropic part of hyperfine field have been given in terms of the hyperfine coupling tensor ($A_{xx} > A_{zz} > A_{yy}$) and the dipolar fields (A_{dip}) arising from external iron moments μ_{Fe}. The obtained from the fitting a small bunching parameter ($\xi \approx 0.05$) of the spiral spin structure results from easy-axis anisotropy in the plane of the iron spin rotation. The Bean-Rodbell magnetostriction exchange model was used to describe the temperature evolution of the reduced hyperfine field.

References

1) I. S. Lyubutin et al., JETP Letters, 12, 798 (2014).