Low-temperature study of magnetization and magnetostriction of $LiYbF_4$ in strong magnetic fields

G.Iu. Andreev[1], I.V. Romanova[1], S. Abe[2], M.A. Cherosov[1], I.F. Gilmutdinov[1], A.G. Kiiamov[1], S.L. Korableva[1], K. Matsumoto[2], O.A. Morozov[1,3], D.S. Nuzhina[1], A.S. Semakin[1], K. Ubukata[2], M.S. Tagirov[1,4]

[1]Kazan Federal University, Kremlevskaia str, 18, Kazan, 420008, Russia
[2]Kanazawa University, Kakuma-machi, Kanazawa, 920-11, Japan
[3]Zavoisky Physical-Technical Institute, FRC Kazan Scientific Center of RAS, Sibirskii trakt, 10/7, Kazan, 420029, Russia
[4]Institute of Applied Research of Tatarstan Academy of Sciences, Levobulachnaia 36a, Kazan, 420111, Russia
E-mail: ujif28@mail.ru

Lithium–rare-earth double fluorides attract interest as model objects in physics of dipolar magnetism. These fluorides share scheelite type, $I4_1/a$ crystal symmetry, unit cell contains two magnetically equivalent rare-earth Re^{3+} ions at sites with the S_4 point symmetry that compose two sublattices. Concentrated tetrafluoride $LiYbF_4$ is XY-dipolar antiferromagnet, $T_N = 0.130$ K, magnetic moments are ordered in (001) plane [1, 2, 3, 4].

Single crystals of $LiYbF_4$ were grown by Bridgeman-Stockbarger method. Powder of $LiYbF_4$ was synthesized by sintering powders of fluorides taken in proportions according to the phase diagrams [3, 5, 6]. Magnetostriction measurements were performed on a home-made capacitive dilatometer [7] in static magnetic fields in the field range 0-8 T. Magnetization of the samples of $LiYbF_4$ was measured by vibration sample magnetometer *VSM* at *PPMS* system at the temperature range 2-300 K and applied magnetic field range 0-9 T. Theoretical analysis was performed using Hamiltonian of rare earth ion, diagonalized in the full space of the energy states of $4f^{13}$ electronic configuration [8].

The qualitative and quantitative agreement between experimental data and simulations has been got both for the powder sample (magnetization measurements) and the single crystal samples (magnetization, longitudinal and transverse magnetostriction measurements) at low temperatures. Also, our theoretical approach explains $LiYbF_4$ single crystal inverse susceptibility experimental data from [2] in an external magnetic field $B = 0.05$ T, $\mathbf{B} \parallel [100]$ and [001], better than the original calculations.

Acknowledgements

The financial support of the Russian Science Foundation (project 22-22-00257) is gratefully acknowledged.

The authors are grateful to Prof. B.Z. Malkin for helpful discussions.

References

1. L.K. Aminov et al. – *Handbook on the Physics and Chemistry of Rare Earths,* **22**, 295-506 (1996).
2. P. Babkevich, et al. – *Physical Review Letters,* **116**, 197202 (2016).
3. R.E. Thoma et al. – *Inorganic Chemistry,* **9**, 1096-1101 (1970).
4. C. Keller, H. Schmutz. – *Journal of Inorganic and Nuclear Chemistry*, **27**, 900-901 (1965).
5. P.P. Fedorov. – *Russian Journal of Inorganic Chemistry*, **44**, 11, 1703–1727 (1999).
6. P.P. Fedorov et al. – *Growth of Crystals*, **21**, 141-154 (2002).
7. S. Abe et al. – *Cryogenics,* **52**, 452-456 (2012).
8. I.V. Romanova, M.S. Tagirov. – *Magn. Reson. Solids,* **21**, 19412 (2019).