Magnetocaloric properties of the $LiGdF_4$ single crystal

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Double fluorides $LiREF_4$ (RE = Gd-Yb) have gained attention as model objects in physics of dipolar magnetism. These fluorides share scheelite type, $I4_1/a$ crystal symmetry; primitive cell contains two magnetically equivalent rare-earth RE^{3+} ions at sites with the S_4 point symmetry that compose two sublattices [1]. The most isotropic material in this fluoride family is $LiGdF_4$ since Gd^{3+} ions in the *s*-state have the spin-only angular momentum $S = 7/2$. This material was recently recognized as an excellent refrigerant material for the low-temperature magnetic cooling, but there is an apparent lack of knowledge on its basic magnetic properties. In particular, no magnetic ordering was observed so far down to temperatures of 0.3–0.4 K [2]. The delayed magnetic ordering can presumably originate from a fine balance of dipolar and exchange interactions that has been found recently [3].

We report the detailed study of the magnetocaloric effect (MCE) in a dipolar-Heisenberg magnet $LiGdF_4$ using magnetization measurements performed on a single crystal sample. Entropy variation on isothermal demagnetization from the magnetic field up to 3 T is determined in the temperature range of 2–10 K for two principal directions of the applied field (parallel and perpendicular to the tetragonal *c*-axis of the crystal). The MCE is found to be highly anisotropic, with the cooling efficiency being up to twice higher at $\mathbf{H} \parallel c$. The results are nicely interpreted in the frame of a conventional molecular field approach taking into account considerable anisotropy of the paramagnetic Curie-Weiss temperature. These results are compared to earlier studies of MCE in powder samples of $LiGdF_4$ [2] as well as with analogous data for other well known magnetocaloric materials. Our findings may open new possibilities to enhance the efficiency of magnetic refrigeration in the liquid helium-4 temperature range.

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