Nuclear Magnetic Resonance and Impedance Spectroscopy Studies on Lithium Ion Diffusion in γ-$LiAlO_2$

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Li ion conductors have attractive properties for application in the field of energy storage. Here lithium aluminum oxide, $LiAlO_2$, has been investigated with respect to motion processes of lithium ions using nuclear magnetic resonance (NMR) spectroscopy for the microscopic as well as impedance spectroscopy (IS) for the macroscopic point of view. Since Li ion diffusion is extremely slow in this material [1], it is relevant for the application as electrolyte additives in batteries [2]. Additionally, $LiAlO_2$ is used as tritium breeding material in fusion reactors and as substrate for the epitactic growth of III-V semiconductors [3]. In the latter cases the small Li diffusivity is important.
In this work we show conductivity spectra of γ-$LiAlO_2$ single crystals purchased from CrysTec and microcrystalline powder prepared by solid state synthesis. For the IS measurements thin films of Pt as well as Ag paste with Pt sheets are used as electrodes.
Furthermore, ^{6,7}Li NMR spectroscopy was carried out on the microcrystalline powder. Line shape and spin-lattice relaxation times were measured in dependence of temperature in order to determine the activation energy of the diffusion process. The measurements were done at high temperatures (from 300 K to 970 K) because of the very slow Li motion. Additionally, spin alignment echo NMR was performed. The jump rate estimated from the averaging of quadrupolar interactions at high temperature is in agreement with the results of spin alignment echo NMR.

References

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