Local Ion Dynamics in β-$LiGaO_2$: A Solid-State NMR Study

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Solid-state nuclear magnetic resonance is an excellent spectroscopic technique to characterize dynamics in materials. It is regularly employed to elucidate wide range of ion dynamics in lithium ion conductors [1]. Materials with fast moving lithium ions find applications in energy storage devices, whereas slow ion motion is used in some devices such as blankets in fusion reactors. β-lithium gallium oxide ($LiGaO_2$) is a slow Li^+ ionic conductor like γ-lithium aluminium oxide ($LiAlO_2$) [2, 3]. Localized motions (to-and-fro jumps) may be present in an ion conductor, in addition to the main diffusion process. In this work, with solid-state NMR experiments, we present our results suggesting localized movements of Li^+ ionic species in β-$LiGaO_2$ in the temperature range between 300 and 450 K. We have mainly extracted the ion dynamics parameters from ^{7}Li spin-alignment echo NMR measurements and the important observation of the partial motional narrowing of the central transition signal of ^{7}Li NMR of polycrystalline β-$LiGaO_2$ prepared by solid-state synthesis [4].

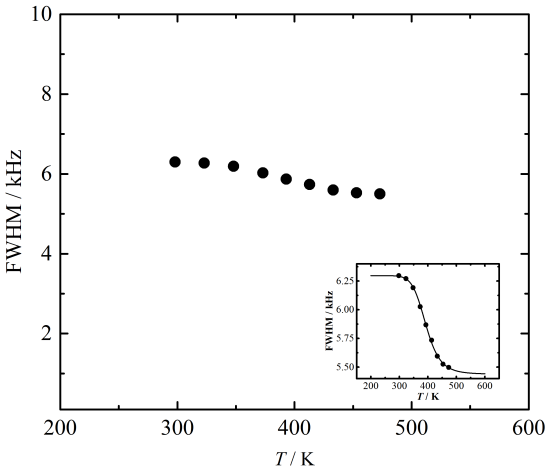

Figure 1: The Full-width at half-maximum of the central transition of static ^{7}Li NMR spectra of β-$LiGaO_2$ plotted against temperature showing partial motional narrowing corresponding to localized motion of a subgroup of the Li ions.

[1] Solid-State NMR Studies of Lithium Ion Dynamics Across Materials Classes, C. V. Chandran, P. Heitjans, Annu. Rep. NMR. Spectrosc. 89 (2016) 1.

[2] NMR and Impedance Spectroscopy Studies on Lithium Ion Diffusion in Microcrystalline γ-$LiAlO_2$, E. Witt, S. Nakhal, C. V. Chandran, M. Lerch, P. Heitjans, Z. Phys. Chem. 229 (2015) 1327.

[3] Unravelling Ultraslow Lithium-Ion Diffusion in γ-$LiAlO_2$: Experiments with Tracers, Neutrons, and Charge Carriers, D. Wiedemann, S. Nakhal, J. Rahn, E. Witt, M. M. Islam, S. Zander, P. Heitjans, H. Schmidt, T. Bredow, M. Wilkening, M. Lerch, Chem. Mater. 28 (2016) 915.

[4] Local Ion Dynamics in Polycrystalline β-$LiGaO_2$: A Solid-State NMR Study, C. V. Chandran, K. Volgmann, S. Nakhal, R. Uecker, E. Witt, M. Lerch, P. Heitjans, Z. Phys. Chem., in press, 2017 (DOI 10.1515/zpch-2016-0920).