

Lithium Diffusion in Oxide Glasses – Bulk Materials vs. Powders

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Transport and dynamics of lithium in amorphous materials is in the focus of two subprojects of the DFG research unit 1277 molife “Mobility of Lithium Ions in Solid Materials”. The subproject TP3 investigates structural control of lithium mobility in different oxide materials including silicates, aluminosilicates, borates and phosphates. A common feature of these materials is that three-dimensional networks are basically formed by interconnected tetrahedra, with 3-coordinated boron as additional unit in the case of borate glasses. Due to different bond strength between T-atoms (Si, Al, B, P) and oxygen and different fractions of non-bridging oxygen, specific potential landscapes are created in the glasses. Mobility of lithium in these materials was studied by lithium isotope exchange experiments (IE, ⁶Li against ⁷Li) with subsequent measurement of profiles of the isotopes using femtosecond laser ablation coupled with plasma mass spectrometry. Additional information was obtained by impedance spectroscopy (IS). Both techniques give access to diffusion coefficient for lithium but probe lithium motion on different length scales. While IS probes short range motion of Li ions, IE is a tool to measure long range transport of Li ions. Highly correlated motion of lithium was found in lithium silicate and borate glass with correlation factors of ≈ 0.5 while in lithium phosphate and lithium aluminosilicate glasses correlation effects are negligible (correlation factor ≈ 1) [1–5].

In powdered glasses the conductivity inside glass particles is only one parameter affecting the bulk transport of lithium. Diffusion on glass surfaces may be a factor enhancing lithium transport. On the other hand, pores and transitions between grains may act as barriers for the long range transport. Such phenomena are investigated in the subproject TP4 of the research unit. A new cell was developed to study changes in material properties during compaction of powder. It allows monitoring changes in sample volume and electrical conductivity in function of temperature and axial pressure. Since surface properties are often sensitive to atmospheric conditions, *i.e.*, water partial pressure, the system can be flushed with pre-conditioned gases. Systematic sets of measurements were performed on lithium silicate powders and lithium magnesium phosphate powders with well defined grain size fractions. Conductivity of compacted powder was found to be very sensitive to pressure both in the brittle and in the plastic deformation regime [6–8].

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