Lithium Mobility in Liquid Crystalline Elastomers

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Liquid crystalline elastomers (LCE) combine properties of liquid crystals with rubber elasticity of the polymer network. The anisotropy of the liquid crystalline structure can be investigated by introducing a spin probe in the system under investigation. The mobility of the spin probe in an orientated sample should differ in the direction parallel and perpendicular to the director.

Kleinschmidt et al. found high anisotropies in the diffusivity of D_2O in low molecular lyotropic mixtures, which strongly decreases for lyotropic crosslinked systems (hydrogels) (1) due to the defects of the network. In thermotropic LCE, we found that a classical spin probe like benzene-d_6 shows only a small anisotropy of the diffusion in a fluorinated smectic-A elastomer.

Using a different system, like Lithium in ethylene oxide chains, we expect higher anisotropy. Smectic-A mesogens with ethylene oxide units as pendant groups provide layered structures and a medium to dissolve Lithium salts. Because of the complexation with the ethylene oxide units, the Lithium ion preferably stays in the ethylene oxide layer. The use of Lithium as spin probe let us not only measure the self-diffusion coefficient by means of NMR but also the ionic conductivity. That means we can also observe the mobility of the ions on a macroscopic length scale.

While isotropic polymers have been extensively studied (2), very few has been investigated about ^{7}Li NMR diffusion in liquid crystalline phases (3-5) due to the limitations of the technique. Furthermore no Li ion conductivity or diffusion experiments has been performed before in a liquid crystalline elastomer so far.

For LCE, we have already observed the influence of the Lithium on the mechanical properties. Measuring diffusion and conductivity on theses systems may help us to understand the structure and topological defects of the polymer network.

^{7}Li NMR measurements in the liquid crystalline phase show that the Li ion is located in a well-defined electronic environment. We performed temperature dependent ^{7}Li and ^{19}F PFG-NMR (pulsed field gradient) experiments to determine the diffusion parallel and perpendicular to the director in the liquid crystalline phase as well as in the isotropic state. An anisotropy in the diffusion is observed in the liquid crystalline phase, which is perfectly correlated with the first ionic conductivity measurements.

References:
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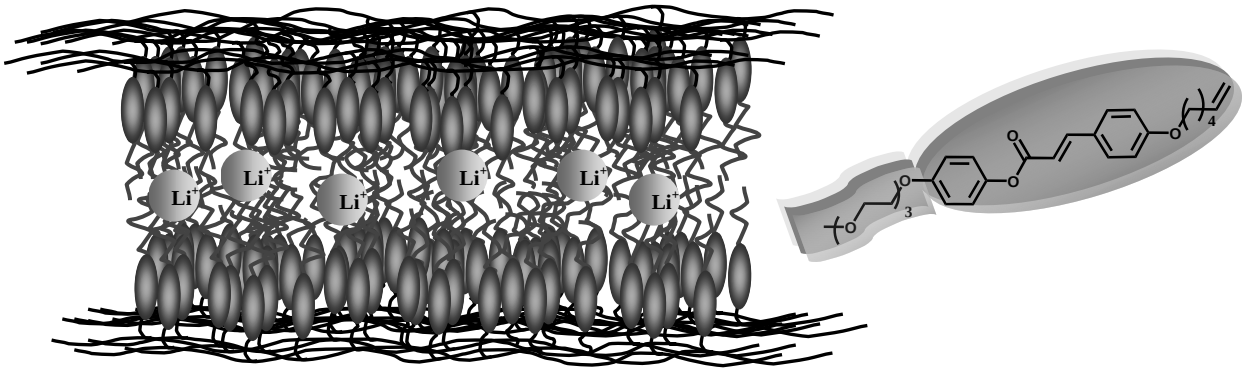

Figure 1: Schematic representation of Lithium ions dissolved in a SmA phase.