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Single Molecule Diffusion in Liquid Crystals

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1. Introduction

Liquid Crystals are a unique mesophase with the order of crystalline materials, but the dynamics of a fluid. Most liquid crystals have building blocks that are dielectric molecules. Therefore the unique properties of these materials can be easily manipulated with external fields. In fact, most applications rely on the connection of order and dynamics within the materials in use. Our goal is to experimentally observe dynamical properties in a Liquid Crystal, the order of the molecules as well as optical quality of the LC cells on a µm-scale. For this, we use mostly single molecule techniques and polarization contrast imaging. The poster will give an overview over our methods as well as results in different Liquid Crystals.

2. Materials and Methods

In order to perform single molecule measurements in Liquid Crystals, we either dope the LC with a fluorescent dye (PDI - Perrylenediimide), or use the selffluorescence of LC molecules to extract dynamical and structural information. Methods are Single Molecule Tracking (SMT), time dependent Fluorescence Depolarization (FD), continuous-wave Fluorescence Depolarization (cw-FD) and Fluorescence Recovery after Photobleaching (FRAP). For information on the spatial variation of optical properties we utilize polarization contrast imaging.

With SMT, the movement of single dye-molecules is analyzed, resulting in a direction dependent diffusion coefficient. Some results of SMT in 8CB are shown in Fig.: 1.

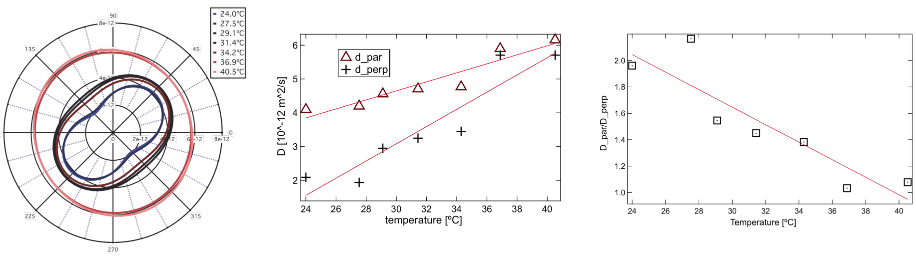

Fig. 1: Temperature dependent mobility of PDI molecules in Liquid Crystal 8CB. From left to right: Angle resolved diffusion coefficients, mobility along the fast and the slow axis and in the right graph the anisotropy of mobility

Continuous-wave Fluorescence Depolarization data contain information on the polarization of emission after polarized excitation. For these measurements, the LC is doped with a higher amount of dye and the data is averaged over several seconds. The experiments give the mean orientation and the order parameter of the dye molecules within the material on a µm-scale. Time dependent measurements in addition give us information about the rotational dynamics within the LC matrix.

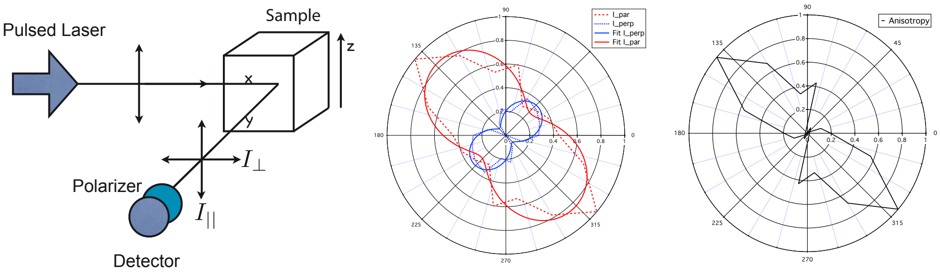

Fig. 2: Fluorescence Depolarization measurement on biaxial Liquid Crystal J35, immersed in 8CB. The sample is rotated and the emission is monitored in two polarization channels, parallel and perpendicular to the excitation. Anisotropy values relate to the amount of order in the material

We use these techniques on PDI in 8CB, on a mixture of 6OCB and 8OCB that show reentrant nematic behaviour and on the biaxial Liquid Crystal J35.

3. Conclusion

We will introduce several single molecule techniques. We use single molecule tracking, fluorescence anisotropy and photoselection in combination with polarization contrast measurements. We experiment on different liquid crystalline systems, to demonstrate that those methods are very well suited to gather information on the unique connection between order and dynamics in different LC systems.