Eötvös Loránd University

Faculty of Sciences

Doctoral School of Physics

Photoalignment in three dimensions

2nd Semester Report

Materials Science and Solid State Physics PhD programme

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Introduction

As I described in the 1st Semester Report, the principal aspect of the research is the experimental study of the photoalignment process in three-dimensions at the polymer—liquid crystal interface, with a special attention to the influence of the molecular structure of the nematic liquid crystal (NLC) on the process. I have continued this work analyzing both azimuthal and zenithal photo-reorientation for various NLCs.

Research work

The observed phenomena (that were listed in the 1st semester report) have been qualitatively explained by the presence/absence of the π-π interaction between the polymer and the liquid crystal. Namely, the molecular sizes of the NLCs rigid core, and that of the photosensitive moiety (azobenzene) of the polymer are such (see Fig. 1(a)) that allow for an offset stacked aromatic π-π interaction between the phenyl rings of the azobenzene moiety and the phenyl rings in the NLC rigid core (if any). Such interaction is shown in Fig. 1(b), for simplicity in case of four benzene rings.

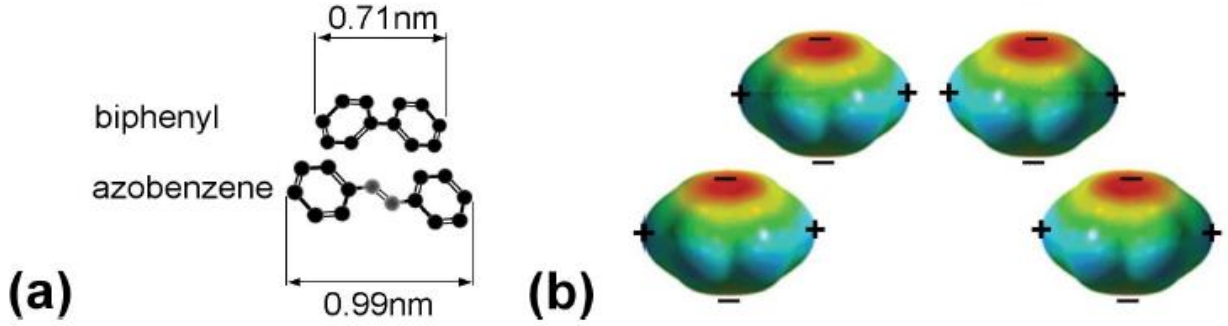

Figure 1. (a) Size of the biphenyl rigid core and that of the azobenzene transisomer. (b) Offset stacked aromatic interaction between benzene molecules enabled by the molecular electrostatic surface potential (MESP, blue is positive, red is negative).

In case of NLCs with a rigid core containing biphenyl, the offset stacked aromatic π-π interaction acts against the photoinduced tran-to-cis isomerization of the azobenzene moiety, and induces additional stresses in the coupled polymer—liquid crystal system. In case of NLCs with phenylcyclohexane, or bicyclohexane rigid core there is no π-π interaction acting against the photoisomerization as it is shown in Fig. 2 schematically.

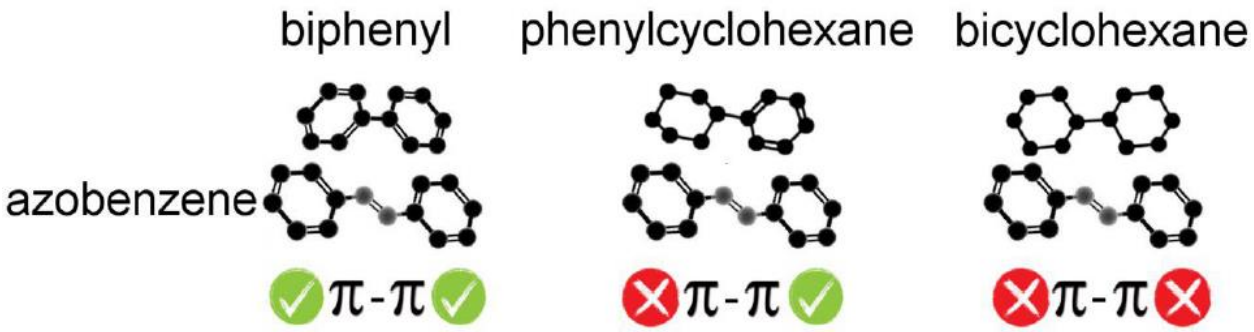

Figure 2. Schematic representation of the presence, or absence of the π-π interaction between the polymer with azo-benzene moiety and various nematic liquid crystals having different rigid molecular cores that were in the focus in our 1st semester experimental studies.

The work has been published in a peer-reviewed scientific journal, *J. Mol. Liq.* (having Q1 ranking and IF: 4.561).

In order to additionally confirm our description, and to make effort in clarifying the role of the flexible alkyl chain in photoalignment, we have extended the experimental work on photoalignment in 3 dimensions to other LCs with the same experimental setup as described in the previous report. Namely, in the 2nd semester we have started measurements on the NLC containing biphenyl in the rigid core, but one of them being modified with three fluorine atoms (5CPUF), which almost "inverts" the MESP of the ring, and on the cyanophenyl-dioxane (PDX) homologous series (as well as on their mixtures). These experiments have been interrupted by the COVID-19 pandemy (Wigner RCP works in a restricted, "emergency" mode), but the results of the performed measurements offer a base for a future publication (with some additional experiments to be done) which is at the level of planning.

Publications

- Nassrah, Ameer R.K., Jánossy, István and Tibor Tóth-Katona, "Photoalignment at the Nematic Liquid Crystal–Polymer Interface: The Importance of the Liquid Crystalline Molecular Structure." *Journal of Molecular Liquids*, **312**, 113309/1-7 (2020). doi:10.1016/j.molliq.2020.113309.

- A.R.K. Nassrah, I. Jánossy and T. Tóth-Katona, *"Photoalignment at the nematic liquid crystal - polymer interface: the importance of the liquid crystalline molecular structure"*. 18th International Conference on Thin Films & 18th Joint Vacuum Conference (ICTF-JVC2020) (**accepted poster contribution**). Originally scheduled to: June 14 – 18, 2020, and postponed to: November 22 – 26, 2020, Budapest, Hungary.

Studies in this semester

- Liquid Crystals, Polymers (Good)
- Technology of Materials (Excellent)
- Physical Materials Science (Good)
- Online course "English for Academic Study" Coventry University.

I have also submitted an application to **International Centre for Theoretical Physics (Italy)** for further experimental research on LCs (application still pending).

Activities

Seminars:

1- Resurgence and Non-perturbative Physics: Applications in Condensed Matter. Speaker: Marcos Mariño (Geneve University, Switzerland), International Centre for Theoretical Physics, 21 Apr 2020.

2- Non-relativistic supergravity and curved supersymmetry, Speaker: Jan Rosseel (Technical University of Vienna, Austria), International Centre for Theoretical Physics, 22 Apr 2020.