Liquid Crystals and Polymers

HEAD:

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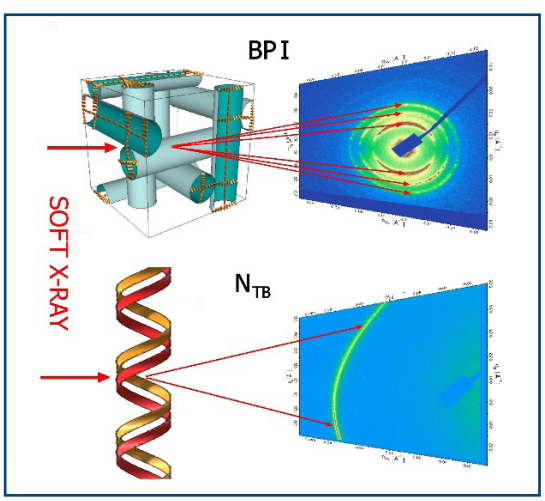
RESEARCH PROFILE:

liquid crystals, polymers, nanoparticles and generally soft matter science

CURRENT RESEARCH ACTIVITIES:

- Chiral structures built form achiral/chiral molecules: chiral symmetry breaking in soft matter is a hot topic of current research. Recently, such a phenomenon was found in a fluidic phase showing orientational order of molecules - the nematic phase; although built of achiral molecules, the phase can exhibit structural chirality as molecules form a short-pitch helices. Recently, similar short-pitch helical structure was confirmed also in the smectic phases by resonant X-ray measurements. Resonant X-ray scattering was also applied to resolve the structure of complex liquid crystalline phases without positional order, e.g. blue phases.



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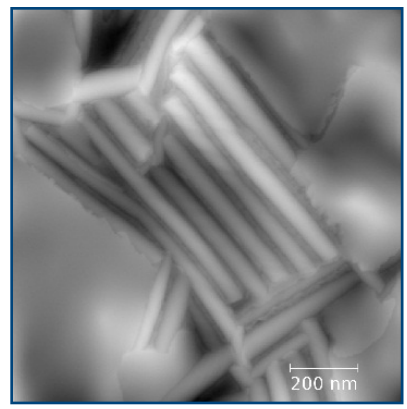
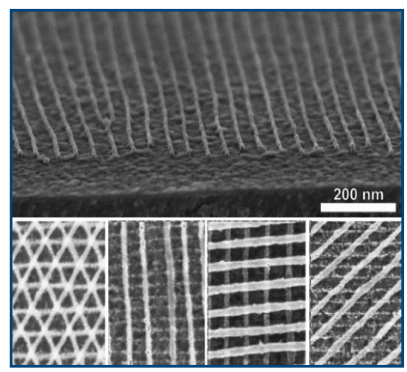
- Complex morphology: nanotubes, nano-ribbons, sponges. The liquid crystalline or crystalline phases made of molecules with non-trivial geometry (e.g. bent-core, dimeric) might exhibits an unusual, highly porous sponge-like, twisted ribbon or tubular morphology. The morphology can be programmed by adsorption of low-weight mesogenic molecules on the crystal surface.



- Organic electronics: Liquid crystals as self-organizing and self-healing materials are often considered as an attractive alternative to solid state electronics and used to produce OLED, OFET and other-type photovoltaic devices. Pre-condition for electronic application of liquid crystalline materials is their fast, anisotropic charge mobility. Efficient charge transport is inherent to many materials forming columnar phases, as the columnar stacking of molecules allows charge hoping between neighboring molecules due to their strong orbitals overlapping.

- Block Co-Polymers: practical application of block co-polymers (BCP) and BCP-derived nanostructures in filtration membranes, transparent electrodes, light polarizers, anti-reflection layers, superhydrophobic coatings, chemical sensors and catalytic materials requires fast and efficient methods for polymer alignment. It was shown that by thermal gradients induced by localized laser heating and shear fields it is possible to align block-copolymer film in less than a second. Utilizing this method novel BCPs architectures can be obtained and further used as templates for the conversion to multi-layered inorganic (metallic or metal oxide) nanostructures with precise spatial control over their chemical composition.



SELECTED PUBLICATIONS:

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2. E. Górecka, N. Vaupotič, A. Zep, D. Pociecha, From sponges to nanotubes – a change of nano-crystal morphology for acute-angle bent-core molecules, Angew. Chem. Int. Ed. 55 (2016) 3468–3472.
3. E. Górecka, N. Vaupotic, A. Zep, D. Pociecha, J. Yoshioka, J. Yamamoto, H. Takezoe, A Twist-Bend Nematic (NTB) Phase of Chiral Materials, Angew. Chem. Int. Ed. 54 (2015) 10155–10159.
4. P.W. Majewski, A. Rahman, C.T. Black, K.G. Yager, Arbitrary lattice symmetries via block copolymer nanomeshe, Nat. Commun. 6 (2015) 7448.
5. P.W. Majewski, K.G. Yager, Latent Alignment in Pathway-Dependent Ordering of Block Copolymer Thin Films, Nano Lett. 15 (2015) 5221-5228.
6. A. Zep, M.M. Wójcik, W. Lewandowski, K. Sitkowska, A. Promiński, J. Mieczkowski, D. Pociecha, E. Górecka, Phototunable Liquid-Crystalline Phases Made of Nanoparticles, Angew. Chem. Int. Ed. 53 (2014) 13725-13728.