Wigner 121
Scientific Symposium

Wigner Research Centre for Physics
Institute for Solid State Physics and Optics
Complex Fluids Department
Partially Ordered Systems Research Group

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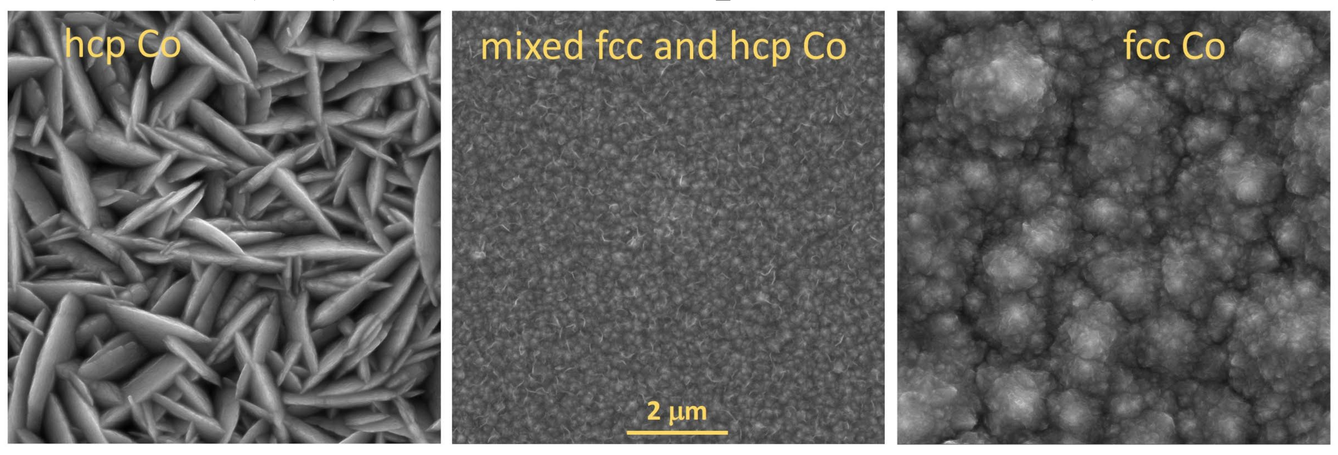
Electrolytic nanostructures

The major goal of the recent activity in the electrodeposition laboratory is to produce metals of desired crystal structure and to optimise the electrodeposition of multi-principal-element alloys.

– Electrodeposition of hexagonal close-packed (hcp) and face-centered cubic (fcc) Co has been optimized [E1] (see below).



– Concentration range of the formation of hcp Co alloys with fcc-forming alloying elements has been established [E2].

– Electrodeposition of Fe-Co-Ni-Zn alloys with near-even mole fractions of the constituents has been optimized [E3]. The hardness of the resulting nanocrystalline fcc alloys exhibited an exceptionally high value (9.2 GPa).

[E1] *Anisotropic magnetoresistance (AMR) of cobalt: hcp-Co vs. fcc-Co.* El-Tahawy et al., J. Magn. Magn. Mater. 560 (2022) 169660

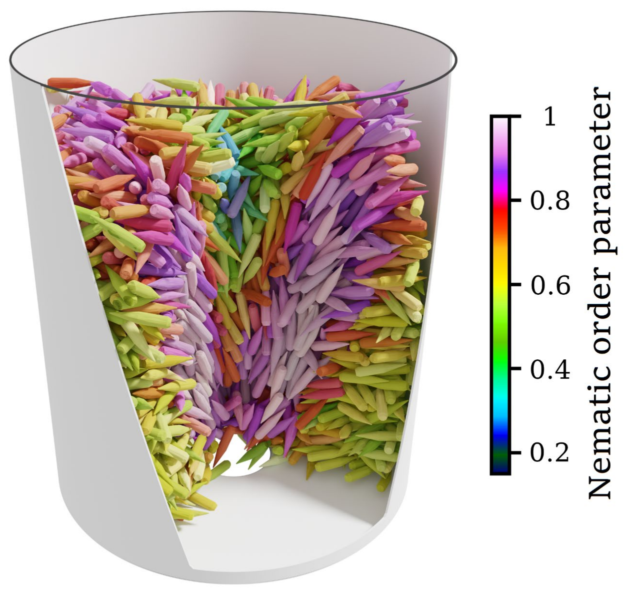
[E2] *Metastable Phase Formation in Electrodeposited Co-Rich Co-Cu and Co-Ni Alloys.* El-Tahawy et al., J. Electrochem. Soc. 170 (2023) 062507

[E3] *Processing and characterization of an electrodeposited nanocrystalline Co–Fe–Ni–Zn multi-principal element alloy film.* Nagy et al., Surf. Coat. Technol. 467 (2023) 129740

Granular materials

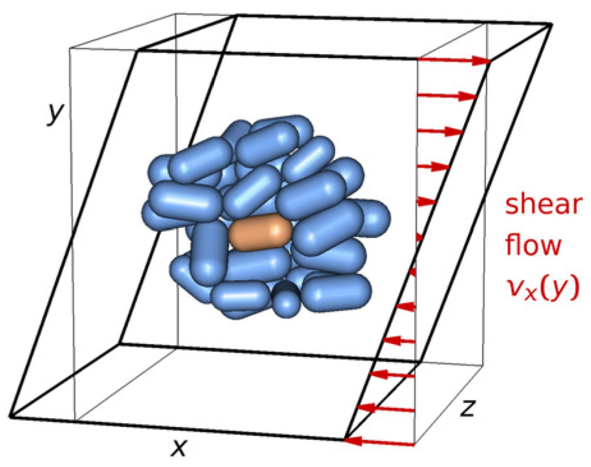
We study the flow of granular materials with special focus on the grain properties e.g. shape, stiffness and surface friction. Laboratory experiments and Discrete Element Model (DEM) simulations are carried out.

– Flow of elongated particles leads to orientational ordering [G1,G3].



– For frictional particles longer grains flow less easily, but for low friction particles grains with intermediate elongation flow less easily compared to spheres or longer grains [G3].

– Hard frictional grains discharge from a silo with constant speed, while for low friction soft grains the discharge speed decreases with decreasing fill height [G2].



[G1] *The role of the particle aspect ratio in the discharge of a narrow silo.* Pongó, Fan, Hernández-Delfin, Török, Stannarius, Hidalgo, Börzsönyi, New J. Phys. 24 (2022) 103306

[G2] *Flow in an hourglass: particle friction and stiffness matter.* Pongó, Stiga, Török, Lévay, Szabó, Stannarius, Hidalgo, Börzsönyi, New J. Phys. 23 (2021) 023001

[G3] *Flow and rheology of frictional elongated grains.* Nagy, Claudin, Börzsönyi, Somfai, New J. Phys. 22 (2020) 073008

Liquid crystals (LCs)

We focus on unique properties of ferroelectric nematics, and on the photoalignment at the LC–polymer interface.

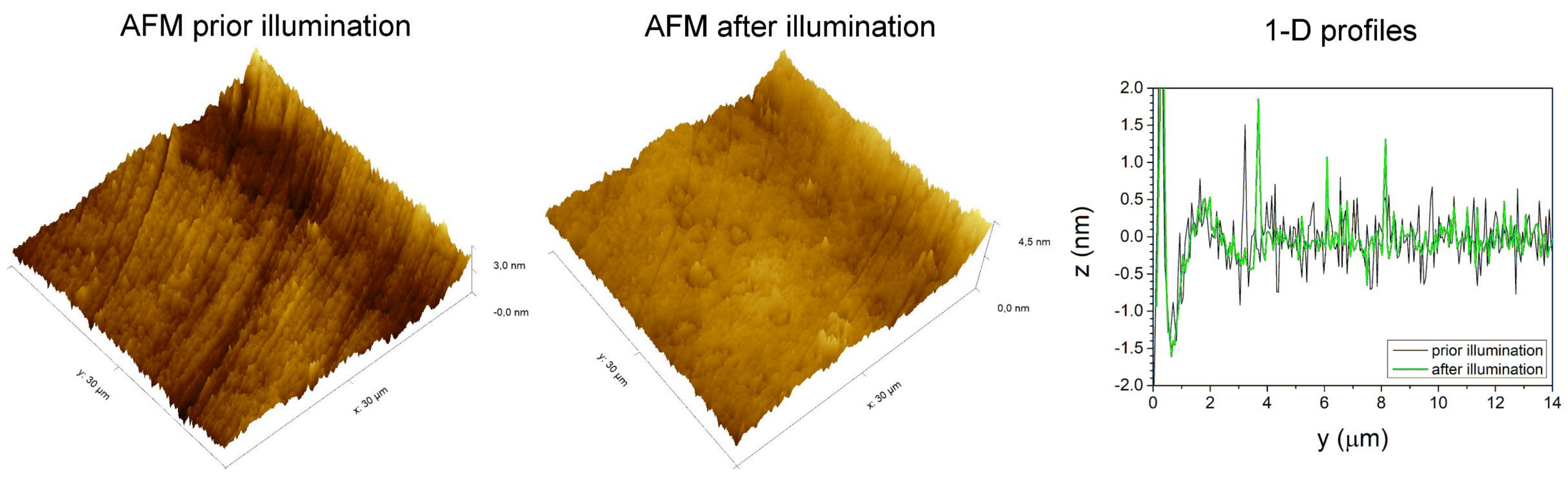
Photoalignment at the LC – polymer interface:

– The role of the LC molecular structure confirmed [L1].

– The importance of the π–π aromatic interaction between LC and polymer established [L1,L2].

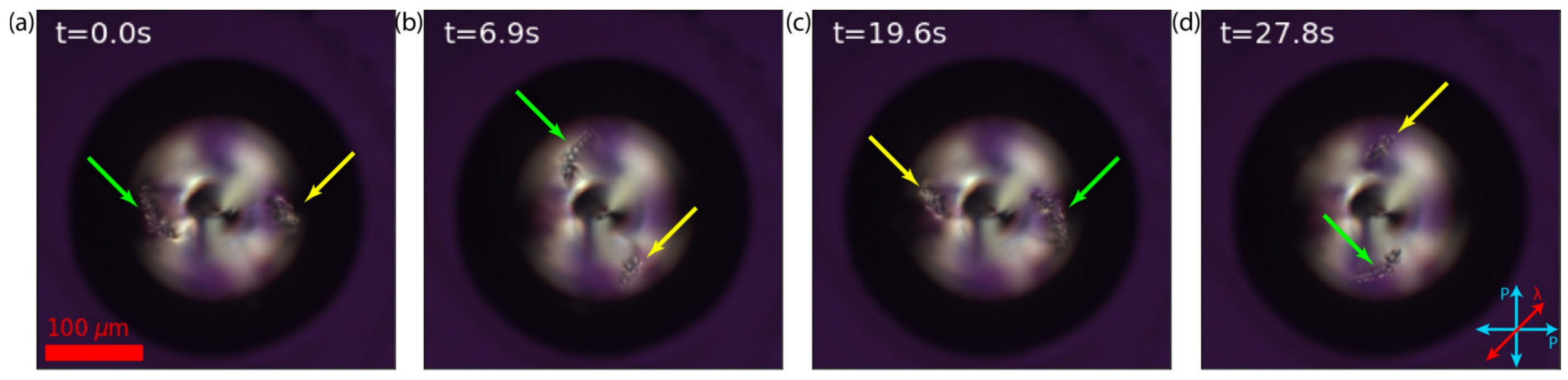
– The influence of the LC phase, and that of the type of the polymer (covalent bonding *vs.* mixing) determined [L2,L3,L4].

– Notable photo-induced mass transfer found in the polymer layer [L4] (see below).

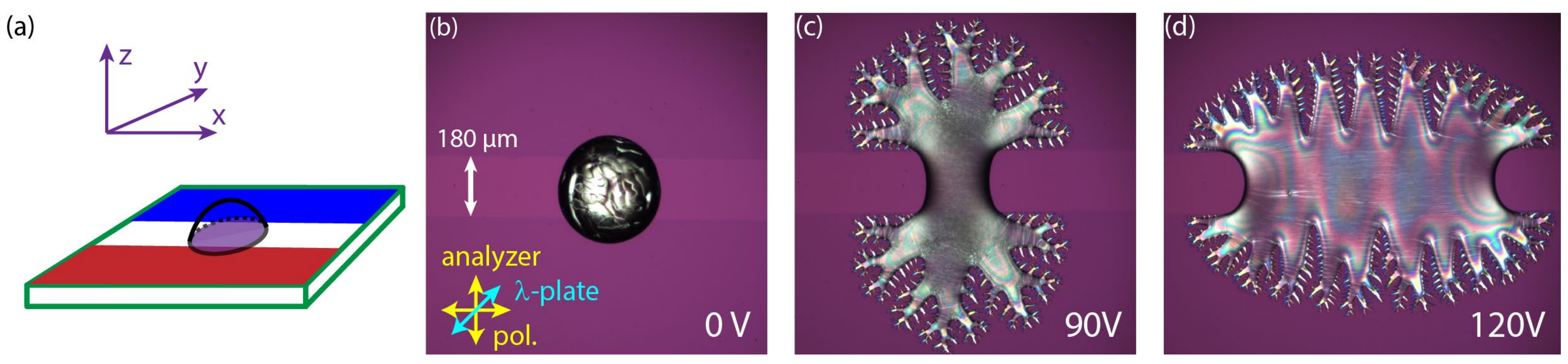


Ferroelectric nematic LCs

– Temperature gradient induces vortex flow in sessile droplets only in the ferroelectric nematic phase [L5]. Orbiting of tracer particles along the molecular orientation and around defects is observable:



– Externally applied electric fields make the free surface of the ferroelectric nematic droplets unstable. Multiple levels of instabilities are observed in various experimental geometries [L6]:



[L1] *Photoalignment at the nematic liquid crystal-polymer interface: the importance of the liquid crystalline molecular structure.* Nassrah et al., J. Mol. Liq. 312 (2020) 169660

[L2] *Polymer-nematic liquid crystal interface: on the role of the liquid crystalline molecular structure and phase sequence in photoalignment.* Nassrah et al., Polymers 13 (2021) 193

[L3] *Photo-orientation of liquid crystals on azo-dye containing polymers.* Jánossy & Tóth-Katona, Polymers 14 (2022) 159

[L4] *Photoaligning polymeric command surfaces: bind, or mix?* Nassrah et al., Polymers (submitted on August 24, 2023)

[L5] *Ferroelectric nematic liquid crystal thermomotor.* Máthé et al., Phys. Rev. E 105 (2022) L052701

[L6] *Electric field-induced interfacial instability in a ferroelectric nematic liquid crystal* Máthé et al., Sci. Rep. 13 (2023) 6981

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