Universität Augsburg University

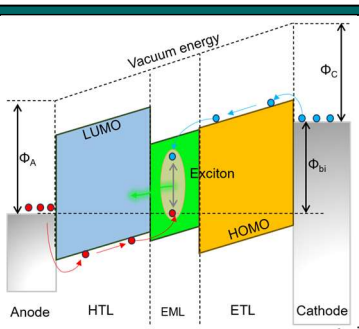
Organic Semiconductors @ Experimental Physics IV

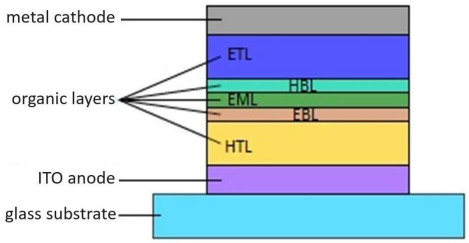
Prof. Dr. Wolfgang Brütting

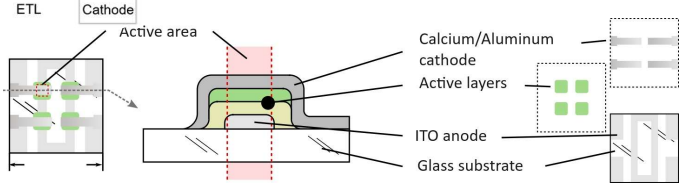


Research Overview

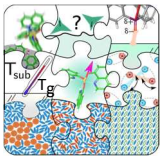
- Thin-film fabrication: spin-coating and physical vapor deposition (PVD).
- Material systems: small-molecule emitters, and perovskite nanocrystals.
- Guest–host (G-H) emission layers: molecular orientation, anisotropy, energy-transfer dynamics.
- Spontaneous orientation polarization (SOP) in polar–polar mixtures: mechanisms and consequences.
- Structure–property correlations from molecular alignment to device-level behavior.
- Comprehensive electrical and optical characterization.



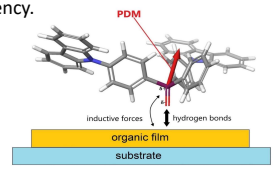




Molecular orientation in mixed organic thin films



- The emission layer (EML) of organic LEDs is typically a thin film of mixed organic guest-host (G-H) materials, comprising an emitter and a (co)host.
- The emitter's orientation in the G-H system significantly impacts OLED efficiency.



➔ What are the driving forces for molecular orientation in thin films?

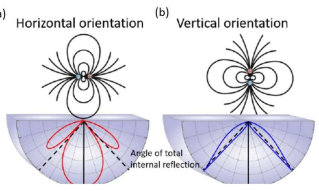
➔ How can we control it?

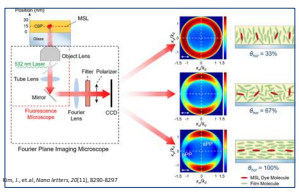
Variable Angle Spectroscopic Ellipsometry (VASE): Optical constants and glass transition temperature (Tg)

- Difference in in-plane and out-of-plane refractive indices (birefringence) hint to molecular alignment.
- Study orientation of emitters mixed in different cohost systems whose T_g is tunable as well as in polar/polar G-H system.



Emitter orientation measured by Angular Dependent Photoluminescence and Back Focal Plane Microscopy

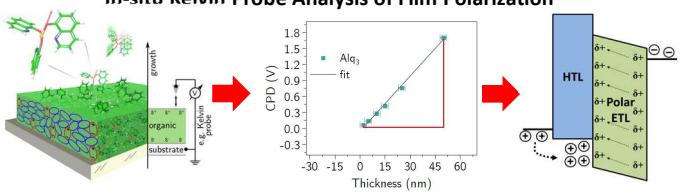




The dependence of emitter orientation on:

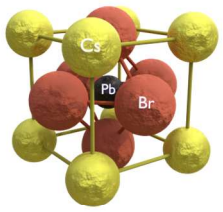
- T_g of cohost
- Birefringence of cohost

In-situ Kelvin Probe Analysis of Film Polarization



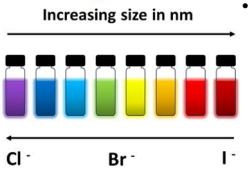
- Macroscopic film polarization results SOP in vapor-deposited polar molecules.
- SOP caused by out-of-plane alignment of the permanent dipole moment of molecules in amorphous films.
- Impact of SOP on charge carrier transport and excitons in OLEDs?

Lead halide perovskite nanocrystals for LEDs

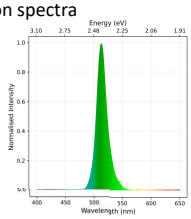


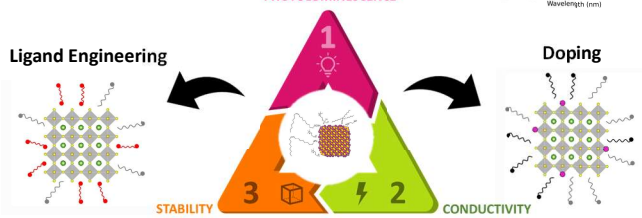
Quantum dot perovskite nanocrystals with ABX_3 crystal structure are excellent candidates for light emitting applications due to their,

- High defect tolerance and quantum efficiency
- Tunable bandgap by size or composition
- Narrow FWHM of emission spectra
- Solution processable





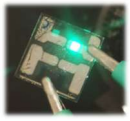


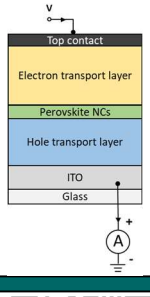


The holy trinity to good nanocrystals for optoelectronics

Possible topics to work on:

- In-operando photoluminescence (PL) studies on LEDs and single carrier devices.
- Ligand exchange on nanocrystals.
- Optical measurements (quantum yield, time resolved PL and temperature dependent studies).
- Device fabrication and characterization.





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