Master's thesis

25. Oktober 2024

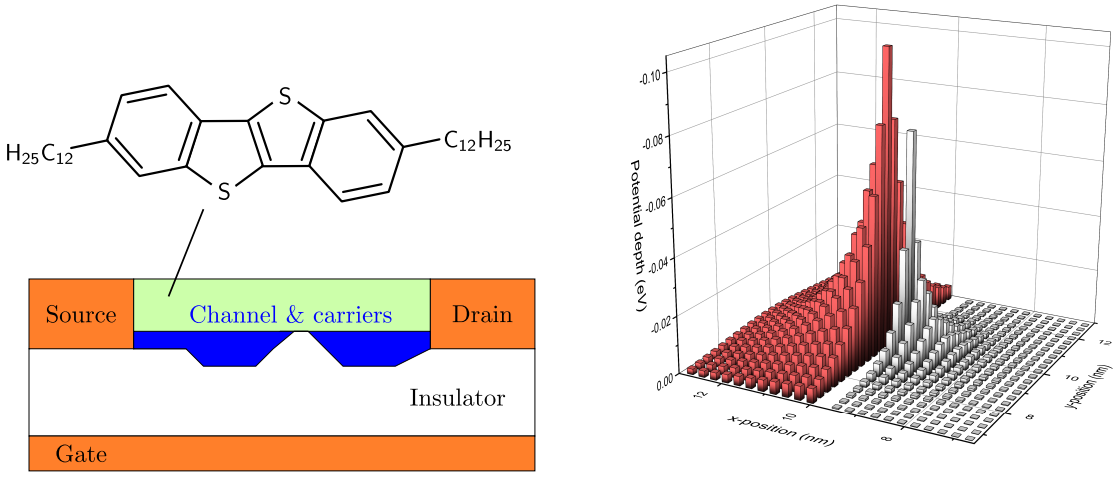
3D-Simulation of Organic Field-Effect Transistors

Background: Organic field-effect transistors are discussed for applications in every day life, such as large area displays, flexible screens, and sensitive electronic skin. One critical prerequisite, however, is a sufficiently large charge carrier mobility within the organic semiconductor. Otherwise these field-effect transistors would be too slow for finding access to the market. Recent research indicates that charge transport can be enhanced by reducing topological inhomogeneities of the organic semiconductor, which opens up new perspectives for the application of organic semiconductors.

Topic and task: The charge carrier distribution within the field-effect devices results from an interplay between Coulomb forces and charge carrier population statistics. Self-consistent numerical solutions of Poisson's equation combined with Fermi-Dirac statistics provides the local charge carrier distributions. The task is to investigate how material inhomogeneities affect the charge carrier density. Atomic force microscopy data reveal the topology of the involved materials. Including these data into the simulation will give insight how the roughness of the materials affects the charge carrier properties.

Start: From 01.01.2025

Status: The program package for the numerical calculations has been developed by the group in 2021. It allows for editing 3D lattices, for uploading AFM data, for the self-consistent solution of the Poisson problem, and for deducing the conductance of the field-effect structure. The package allows for simulating a device comprised of 10^6 nodes within about 2 hours.



Left: Schematic of an organic field-effect transistor and the charge carrier channel between Source and Drain (blue). Right: Simulation of the potential around a single defect.

Literature: A. Sailer et al, Appl. Phys. Lett. 117, 083301 (2020); `https://doi.org/10.1063/5.0015585`

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