An existence result for a class of electrothermal drift-diffusion models with Gauss–Fermi statistics for organic semiconductors

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This work is concerned with the analysis of a drift-diffusion model for the electrothermal behavior of organic semiconductor devices. A "generalized Van Roosbroeck" system coupled to the heat equation is employed, where the former consists of continuity equations for electrons and holes and a Poisson equation for the electrostatic potential, and the latter features source terms containing Joule heat contributions and recombination heat. Special features of organic semiconductors like Gauss–Fermi statistics and mobilities functions depending on the electric field strength are taken into account. We prove the existence of solutions for the stationary problem by an iteration scheme and Schauder's fixed point theorem. The underlying solution concept is related to weak solutions of the Van Roosbroeck system and entropy solutions of the heat equation. Additionally, for data compatible with thermodynamic equilibrium, the uniqueness of the solution is verified. It was recently shown that self-heating significantly influences the electronic properties of organic semiconductor devices. Therefore, modeling the coupled electric and thermal responses of organic semiconductors is essential for predicting the effects of temperature on the overall behavior of the device. This work puts the electrothermal drift-diffusion model for organic semiconductors on a sound analytical basis.