A commercial TCAD based modeling framework for electrolyte-gated organic thin-field transistors used as biosensors

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In this work a **commercial TCAD based mathematical and physical modeling framework of electrolyte-gated organic thin field transistor (EGOTFT) based biosensors** is presented. The TCAD implementation makes it possible for the model to be numerically stable in a wide parameter range and to be easily extendable with the various electrical and optical models offered by the software. This framework has proven to be general enough to reproduce the transfer characteristics of **three types of EGOTFT based biosensors. These are devices for sensing (1) KCl concentration (2) pH and (3) protein binding**. The latter is made possible by functionalizing the sensor surface with mPEGBiotin and binding the protein CaptAvidin. The sensors used for model validation are made with **poly(3-hexylthiophene) semiconducting material** and all setups are subject to research going into low-cost disposable biosensing devices. **The model reproduces the linear regime of the transfer characteristics well**, but in the nonlinear regime the switch-on drain current is underestimated. To our beliefs a more elaborate model would also get rid of this discrepancy. The **electrical double layer capacitance is also fit to measurements**, and in most cases a reasonable fit is achieved, which is astounding, taking into account how simple the model is. This framework makes it possible to either develop new devices or investigate their governing physical principles, provided one makes the model sufficiently refined.

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