OptiPV: A collaborative simulation platform for photovoltaics

M. Giteau[1], D. N. Micha[2,3], S. Collin[2,3] and J.-F. Guillemoles[2,4]

[1]Research Center for Advanced Science and Technology, The University of Tokyo, Japan

[2]Institut Photovoltaïque d'Ile de France (IPVF), France

[3]Centre de Nanosciences et de Nanotechnologies (C2N), CNRS, Université Paris-Saclay, France

[4]UMR IPVF 9006, CNRS, Ecole Polytechnique Institut Polytechnique de Paris, PSL Chimie ParisTech, IPVF SAS, France

To achieve efficiencies ever closer to the theoretical limits, models that accurately describe the physics of the underlying solar cell are required. Among other properties, the optimization of the optical absorption is of critical importance, especially in ultrathin devices. However, even for 1D-numerical methods such as Transfer Matrix and Scattering Matrix methods, the available simulation tools often do not satisfy the user's needs, because they do not implement certain features (non-normal light incidence, incoherent layers, roughness…), and/or because the material database is not suitable. As a result, a new implementation may be written from scratch, a time-consuming task that suffers the same short-comings: codes developed by researchers are often not conceived in a way they can easily grow to fit the requirements of other potential users (one might not even remember how to operate one's own code after a few months or years).

To address this issue, we started developing a simulation platform called OptiPV to simulate and optimize photovoltaic devices, especially regarding their absorption. The code, which runs on Matlab, was launched as a collaborative project on GitHub. It includes a graphical interface (similar to SCAPS) that allows the user to easily define the structure and simulation parameters. It can be used to optimize certain parameters of the device, or to provide a comparison with experimental data. The database already contains numerous materials obtained from the literature and experimental measurements, but new materials can also easily be added to the database by the user. One key feature of the code is its underlying architecture that allows a lot of modularity: the different properties are grouped into standardized objects that can easily be transferred between different modules. For example, the absorption can be computed using Transfer Matrix or RCWA (others to come) with the same types of inputs and outputs. Current developments include the possibility to interface the result objects with SCAPS and detailed balance models, in order to simulate I-V responses. In the near future, the code will be able to simulate devices such as absorbers with periodic nanostructures, multi-junction solar cells and hot-carrier solar cells. As the objective is for the platform to be collaborative, this presentation will be an opportunity to present the current features of the code to the community, so that interesting new ideas can be identified and implemented in the future.

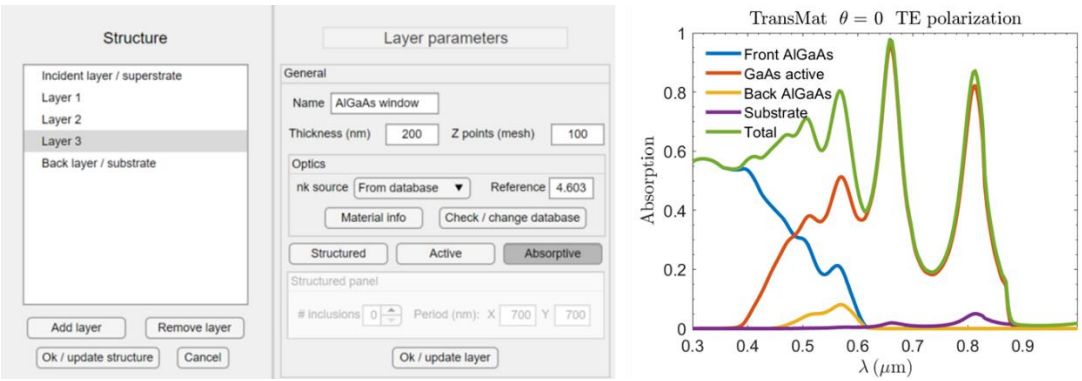

Figure 1: (Left) The graphical interface to define the different layers of the stack and their properties. (Right) The absorption in each layer can be computed and represented automatically for a defined set of parameters.