SMA-1D a PV module CTM analyzer

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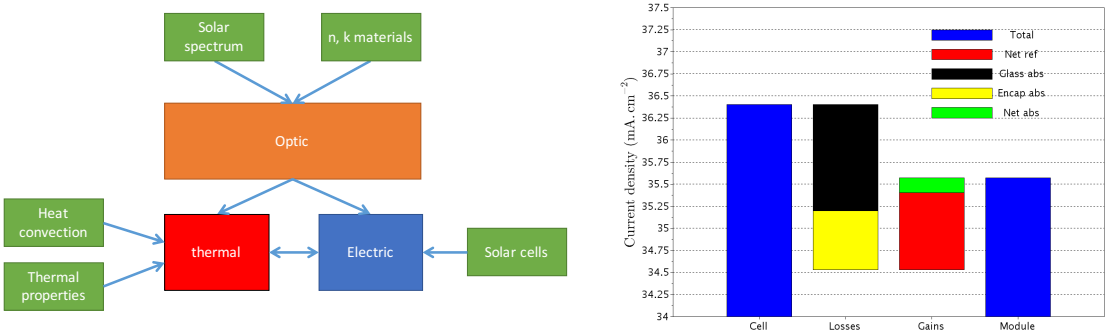
Abstract

A solar module can be optically modelled as a stack of materials. In order to obtain the photonic absorption in each layer of the stack, the reflection, the transmission and the absorption at each interface between the layers have to be determined. They are governed by the Snell's law and the Fresnel equations [1]. However, two kinds of interfaces have to be considered. The first is in between two incoherent materials. In this case, the absorption at the interface is null and only occurs in the incoherent materials themselves. The second is for interfaces with coherent materials. A coherent material is an optically thin material, e.g. the ARC layers in PV modules. The absorption in these layers is not null and interferences must be considered [2].

We present in this papier an in-house simulation tool, Solar Module Analyzer 1D (SMA-1D), is developed on free and Open Source Software for numerical simulation Scilab. It simulates the optical and electrical behaviour of a solar module based on the optical indexes of the materials making up the module and the collection efficiency of the solar cells in it. The stack of materials modelling the module is considered in only one dimension, perpendicular to its largest surface. In glass-glass modules this hypothesis is close to the 2D simulation whereas for modules with backsheets, the possible gains from Lambertian reflection at the Inter-cell spaces must be considered. Thanks to SMA-1D, the distribution of the spectral absorption in the stack of materials of a module is obtained as well as the J_{sc} corresponding to an incident spectrum. The cells and the module parameters are listed in Table I. The external and internal glass ARC indexes are chosen to maximize the incoming photonic flux and do not absorb light. The cell collection efficiency corresponds to an average Al-BSF cell.



(a) (b)

Figure : (a) SMA-2D algorithm (b) A CTM calculation of a standard PV module.

Bibliographie

[1] D. Windt, "IMD—Software for modeling the optical properties of multilayer films," Comput. Phys., vol. 12, no. 4, 1998.

[2] T. Lanz, B. Ruhstaller, C. Battaglia, and C. Ballif, "Extended light scattering model incorporating coherence for thin-film silicon solar cells," J. Appl. Phys., vol. 110, no. 2011, p. 33111, 2011.