MAP-fis Essay Proposal, 2014-2015

Supervisor

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Title

Enhancing photovoltaic cells performance through anti-reflective and emitting layers

Area

Materials, Optics

Summary of Proposal

Self-cleaning and anti-reflective layers aim at increase efficiency and reduce the cost of photovoltaic energy conversion; however economically profitable devices have not yet been reached. The relevance of this topic is well-known in solar cell fabrication process; for instance, for a Si-based PV cell, reflectance (R, according to Fresnel relation) varies from 31% to 51% at 1.1 µm to 0.40 µm respectively. So, without a reflective layer, a PV cell based on Si would only transmit about 70% of IR and 50% of UV portions of the sunlight into the cell. Moreover, a further increase in the energy conversion efficiency of silicon based solar cells may also be attained by exploiting the solar spectrum region below 400 nm (high-energy photons not efficiently converted from Si). Thus, the incorporation of optically active centers that efficiently absorb high-energy photons and convert them to lower energy ones (down-shifting or down-converting layers) that are efficiently absorbed by Si is another interesting and actual aspect of solar cells processing. Theoretical calculations predicted that the use of such layers in conjunction with a silicon solar cell can achieve a conversion efficiency of up to 38.6%.

This essay aims at describing the state-of-the-art of self-cleaning, anti-reflective and down-shifting layers in terms of the materials and processing methods used to develop them. Emphasis will be also given to the their performance characterization through the identification of the relevant parameters and the subjacent theoretical modelling and experimental techniques.

The main limitations and challenges will be identified and compared with other solutions to enhance light trapping in photovoltaic energy conversion.

Prospecting innovative R&D in the field, the used of films of pristine organic-inorganic hybrids and doped with lanthanide ions or organic dyes will be also included.

References

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