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ABSTRACT:

The Hot Carrier Solar Cell as Thermoelectric Converter

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The Hot Carrier Solar Cell (HCSC) is a solar energy conversion concept, initially suggested by A. Nozik in 1982 [1] and revised by P. Würfel in 1997 [2] by introducing the concept of energy selective contacts (ESCs). The concept is interesting from a physics perspective because it provides an alternative route to conventional solar cells for engineering a photovoltaic device exhibiting a limiting efficiency of 85.4 %.
In its simplest formulation, the HCSC involves two elements: the photon absorber and the above mentioned ESCs. In this solar cell, photons from the sun heat-up electrons in the absorber, that can have zero bandgap, up to a temperature T0. These electrons are then extracted through the ESCs that have the property of cooling down the electrons while raising their electrochemical potential or, as electrical engineers prefer to describe it, inducing a "voltage" output at the terminals of the solar cell. This property is derived from the fact that ESCs are assumed to transport electrons only within a narrow energy band. However, often additional idealizations are demanded such as, for example, the need for suppressing electron interaction with phonons in the absorber. In this work we will illustrate that many of these other idealizations are not needed and that the operation of a HCSC can be regarded as the operation of an ideal thermoelectric converter.

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[1] R. T. Ross and A. J. Nozik, "Efficiency of hot-carrier solar energy converters," J. Appl. Phys., vol. 53, no. 5, pp. 3813–3818, 1982.
[2] P. Wurfel, "Solar energy conversion with hot electrons from impact ionisation," Sol. Energy Mater. Sol. Cells, vol. 46, no. 1, pp. 43–52, 1997.