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Combined conversion of heat and light with Photon Enhanced Thermionic Emission for solar energy harvesting

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Recently a new mechanism for solar energy harvesting based on photon-enhanced thermionic emission (PETE) was proposed. This two-step process uses photons to excite carriers into the conduction band, followed by thermionic emission from the conduction band, and electron collection at a low-workfunction anode. This process effectively combines both heat and light, and its efficiency was calculated to exceed ideal single junction photovoltaics since it harvests some of the heat that is normally lost within PV devices. Experimental measurements demonstrated this mechanism in GaN materials, yet the quantum efficiency was very low. Here we discuss the loss mechanisms in the PETE process, and several approaches to overcome them. In particular we focus on surface recombination effects and absorption losses, and demonstrate a heterostructured device that increases the quantum efficiency by two orders of magnitude. Prospects for combined-cycle devices incorporating a PETE converter as a topping cycle on conventional thermal cycles are also analyzed.