Angular restriction of photon emission for ultra-efficient photovoltaics: prove of concept

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We present the experimental evidence of enhancing the performance of ultra-efficient solar cells by external recycling of photon emission [1]. It is equivalent to restricting the angular range of photon emission, and can only be effective in photovoltaics with high external luminescent efficiency (Q_E). This has precluded the voltage enhancement from being observable in today's photovoltaic technologies. As shown here, however, it is attainable with the latest generation of champion single-junction one sun thin-film GaAs cells [2].

The magnitude of the observed open-circuit voltage (*Voc*) enhancement is modest: 4 mV at a nominal *Voc* of 1120 mV – well below the maximal theoretical increase of 275 mV for the ideal case of perfect photon recycling (i.e., photon emission restricted to the solar angular radius) and $Q_E = 1$. The large difference between the maximum theoretical enhancement of *Voc* and our measured values is consistent with basic theory – explained by Q_E for our device being well below unity.

However, when innovative cell design and manufacture can attain significantly higher values of Q_E , the benefit of photon recycling can be considerable. Such future improvements could emerge from the conflation of substantially thinner cells with superior light-trapping nano-structure, to yield the necessary near-unity values for both external luminescent efficiency and net radiative recycling efficiency.

References

1. 80. A. Braun, E. A. Katz, D. Feuermann, B.M. Kayes, J.M. Gordon, *Energy & Environ. Sci.*, 6, 1499 - 1503 (2013).

2. http://www.altadevices.com