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Detailed Balance Comparison of the Series and Non-Series Tandem Solar Cell[1] OCTAVI E. SEMONIN, ROBERT A. BARTON, Energy Frontier Research Center, Columbia University, IOANNIS KYMISSIS, Electrical Engineering, Columbia University — Using thin film multijunction photovoltaics to achieve higher power conversion efficiency has been proposed as a means to lower costs in next generation solar cells. As they are typically constructed, each cell is connected in series to the next, with each cell having a band-gap optimized to more efficiently harvest energy from a subset of the solar spectrum. However, the series-constrained solar cell limits the range of materials compatible because any excess current generated by any cell in the structure is lost. In this work, we use the detailed balance analysis developed by Shockley and Queisser to show how inserting a third transparent electrode between two active layers can dramatically increase the range of materials for which a tandem structure can break present efficiency limits. We show that the non-series architecture exceeds 40% power conversion efficiency for five times as many band-gap combinations as the series tandem, significantly expanding the materials phase-space available to researchers. We apply this analysis to the case study of thin film structures built on the ubiquitous silicon platform.

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Octavi E. Semonin
Columbia Univ

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