Tandem Solar Cells: State of the Art and Recent Advances

M. Gueunier-Farret[1], J. Alvarez[2,3] A. Bojar[3], S. Collin[4,3], J.P. Connolly[2,3], J.-F. Guillemolles[3], J.-P. Kleider[2,3], C. Longeaud[2,3], N. Naghavi[3], P. Schulz[3]

[1] Université de Bordeaux, IMS-CNRS, UMR 5218, Bordeaux INP, ENSCBP, F33405 Talence, France
[2] Université Paris-Saclay, CentraleSupelec, CNRS, Laboratoire de Génie Electrique et Electronique de Paris, 91192, Gif-sur-Yvette, France
[3] IPVF, Institut Photovoltaïque D'Ile-de-France, 91120, Palaiseau, France
[4] Centre for Nanoscience and Nanotechnology (C2N), CNRS, Université Paris-Saclay, 91120 Palaiseau, France

Photovoltaics has become a mature industry with continuous improvement in the performance and lifetime of PV modules. However, the efficiency of commercialized PV devices is getting closer and closer to the single-junction theoretical Shockley-Queisser (SQ) limit [1]. The development of new concepts to surpass the SQ limit is therefore a hot topic in PV research. Among the main candidate technologies (hot carriers, up-conversion and down-conversion, light concentration …), multijunction devices are the only concept which have surpassed the SQ limit by a wide margin. Multijunction devices are therefore the most promising solution for industrialization in the near future, and the dominant multijunction design today is the tandem solar cell.

After a description of the working principles and functional advantages of multijunction solar cells, we review the current status of tandems. We compare different types of tandem solar cells according to their design and subcell materials (III-V, perovskite, CIGS, organic materials…) and discuss their potential and challenges. In particular, we discuss the recent advances in tandem lab cells with a Si bottom cell for which some technologies already demonstrate conversion efficiencies very close to or even higher than the Si single junction SQ limit.

[1] W. Shockley, H.J. Queisser, Detailed Balance Limit of Efficiency of p-n Junction Solar Cells, J. Appl. Phys. 32 (1961) 510–519. https://doi.org/10.1063/1.1736034