

Large area 23% monolithic perovskite/homo-junction-silicon tandem solar cell with enhanced UV stability using down-shifting material

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Metal halide perovskite is a promising material for Si-based tandem due to rapid improvement in energy conversion efficiency of perovskite solar cells [1]. However, to improve their commercial prospects, UV stability must be improved. Herein, we report an elegant approach of incorporating down-shifting material onto the perovskite/Si tandem solar cells building on our previous work that use homo-junction Si bottom cells with a simple interface-layer-free approach for monolithic intergration [2-3]. This approach is suitable for large area cell e.g., 4 cm² tandems are used in our demonstrations and brings about multiple advantages such as i) antireflective control for the top cell and light trapping for the bottom cell (improving cell efficiency from a baseline of 20.1% to 22.3% brought about by the texturing alone), ii) improvement in UV response circumventing parasitic absorption by the “sun-facing” carrier transport layer (improving cell efficiency further to 23.1% brought about the incorporation of down-shifting material), iii) increased moisture resistance by the texturing and iv) improved UV stability (most stable cell maintained 90% of its initial performance after 1 month of continuous UV light soaking). To our knowledge, this is the first time the concept of down-shifting is applied on tandem solar cells. The champion perovskite/Si device has a steady-state power conversion efficiency of 23.0% and a fill factor (FF) of 81%, which are the highest values to date for monolithic perovskite/Si tandem that uses homo-junction-silicon as the bottom cell. The demonstrated efficiency and stability enhancement by such elegant approach paves a way for improving the commercial viability of perovskite/silicon tandems and other perovskite photovoltaic applications.

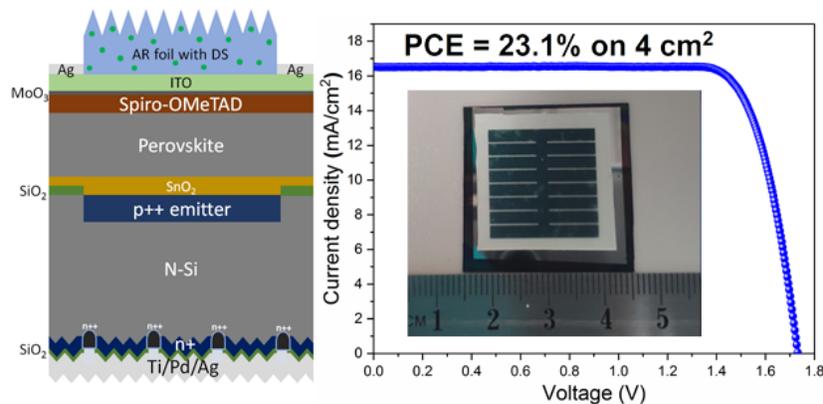


Figure 1. Schematic and photo of monolithic perovskite/silicon-homojunction solar cell using down-shifting material.

References

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- [2] Zheng, J., Lau, J., Mehrvarz, H., Ma, F.-J., Jiang, Y., Deng, X., Soeriyadi, A., Kim, J., Zhang, M., Hu, L., Cui, X., Lee, D. S., Bing, J., Cho, Y., Chen, C., Green, M. A., Huang S., and Ho-Baillie, A., 2018 'Large area efficient interface layer free monolithic perovskite/homo-junction-silicon tandem solar cell with over 20% efficiency', *Energy & Environment Science*, 11, p2432-2443.
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