Comparative analysis of the performance and stability of Si/PK tandem cells under real-world and laboratory conditions

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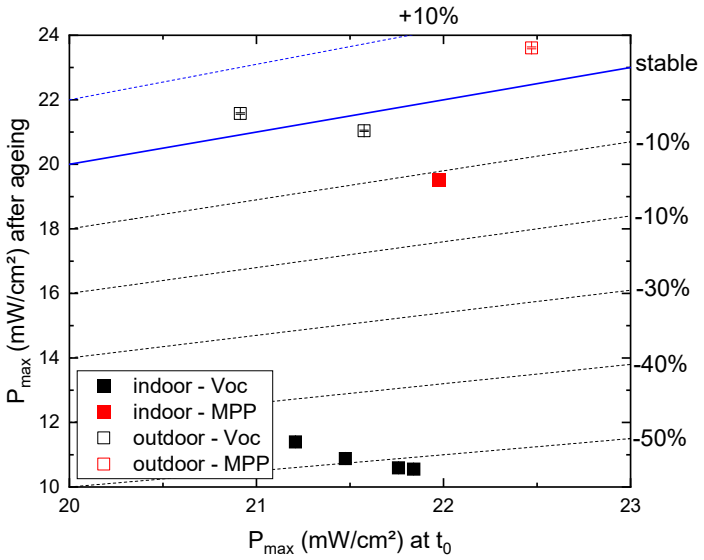
Photovoltaic tandem cells, combining Silicon (Si) and perovskite (PK) materials have emerged as promising candidates for efficient and cost-effective solar energy conversion. One of the major challenges for the development of this technology remains the stability of the devices, particularly under illumination. There are very few articles mentioning stable devices under illumination[1,2] and, to our knowledge, none for devices larger than 1cm². Understanding their stability and performance under different operational conditions is critical for their successful integration into practical applications.

In this study, we investigate the behaviour of 9cm² Si/PK tandem cells under real conditions at Voc or MPP, and laboratory-based illumination scenarios (continuous or day/night cycling). Comparison of the evolution of their electrical performance reveals notable differences in the degradation behaviour of these tandem cells under various conditions.



First results reveal:

- Under real-world conditions, at Voc or MPP, where cells are exposed to the natural diurnal light cycle, Si/perovskite tandem cells exhibit significantly enhanced stability compared to their counterparts tested solely under laboratory illumination
- Under continuous illumination, cells operated at MPP exhibit superior stability when compared to cells operated under Voc.

The observed differences in degradation behaviour can be attributed to a combination of factors, including temperature variations, light-induced stress, recovery in dark, and potential-induced degradation and will be discussed in the final paper. On the one hand, these findings highlight the promising stability in relevant outdoor conditions (MPP), but on the other hand call for a comprehensive understanding of the complex interplay between external factors and device operation in order to design more resilient and durable tandem photovoltaic devices.

In conclusion, our study provides valuable insights into the performance and stability of Si/perovskite tandem cells in both real world and laboratory conditions. In addition, to our knowledge, this paper is the first to demonstrate stability for at least 500 hours under real conditions for a Si/PK tandem cell larger than 1cm².

1. Babics, M. *et al.* One-year outdoor operation of monolithic perovskite/silicon tandem solar cells. *Cell Reports Phys. Sci.* **4**, 101280 (2023).
2. Liu, J. *et al.* 28.2%-efficient, outdoor-stable perovskite/silicon tandem solar cell. *Joule* 1–18 (2021) doi:10.1016/j.joule.2021.11.003.