

# Quantifying Mobile Ions in a Perovskite-based Tandem Solar Cell

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## Background

Perovskite-tandem solar cells are an incredibly promising pathway in the future of solar energy, offering more power for the same amount of sunlight. Silicon or perovskites individually can only reach around 27% efficiency, but combined have reached around 35% efficiency (with the potential to reach ~45%). Their configuration can be tricky, as a perovskite's weaker ionic bonds, compared to a silicon's stronger covalent bond, can influence charge transport and impact the devices long-term stability. This research aims to measure the mobile ion concentration in perovskite, silicon, and tandem cells to better understand how it affects device performance and stability.

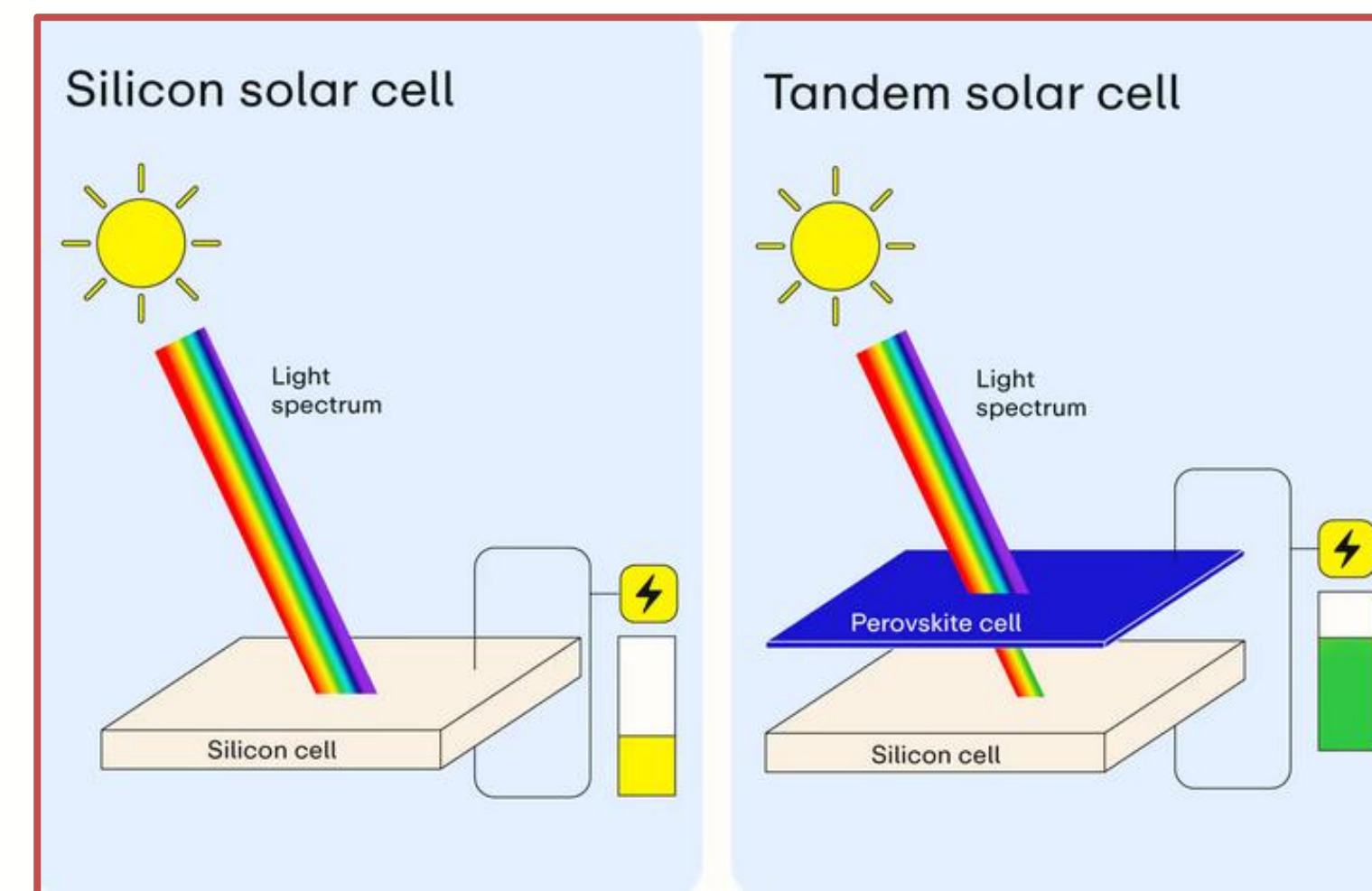


Figure 1. Comparison of silicon and tandem solar cells<sup>2</sup>

## Methodology

- Utilize a solar cell holder that can measure perovskite, silicon, and tandem cells to minimize equipment interference.
- Making use of PAIOS software, take JV (current density-voltage) measurements for device performance and TDC (transient dark current) measurements to observe decay of current in the device over a short period of time.
- Using TDC measurement data, determine the mobile ion concentration using a validated calculator<sup>1</sup>.
- Repeat for multiple cells or multiple times for single cell.

## Conclusion and Future Work

As expected, the results demonstrated tandem cell's higher mobile ion concentration compared to a base perovskite and a silicon cell. The presence of mobile ions in silicon cells is unexpected as they are not thought to be composed of mobile ions, although hydrogen could be the source<sup>3</sup>. The future for tandem cells is looking bright, with more companies and startups popping up than ever before, hoping to harness the power they hold. Future work will focus on isolating each component of the tandem cell to identify sources of instability and determine how mobile ion effects can be reduced without compromising performance.

## References

1. Tippin, F. (n.d.). *Mobile ion calculator*. Arizona State University.
2. Oxford PV. *Technology*. <https://www.oxfordpv.com/technology>
3. K. Gmucová, V. Nádaždy, and R. Durný, "The nature of mobile hydrogen in a-Si:H—Electrochemical studies," *Solar Energy*, vol. 80, no. 6, pp. 694–700, 2006.

## Results

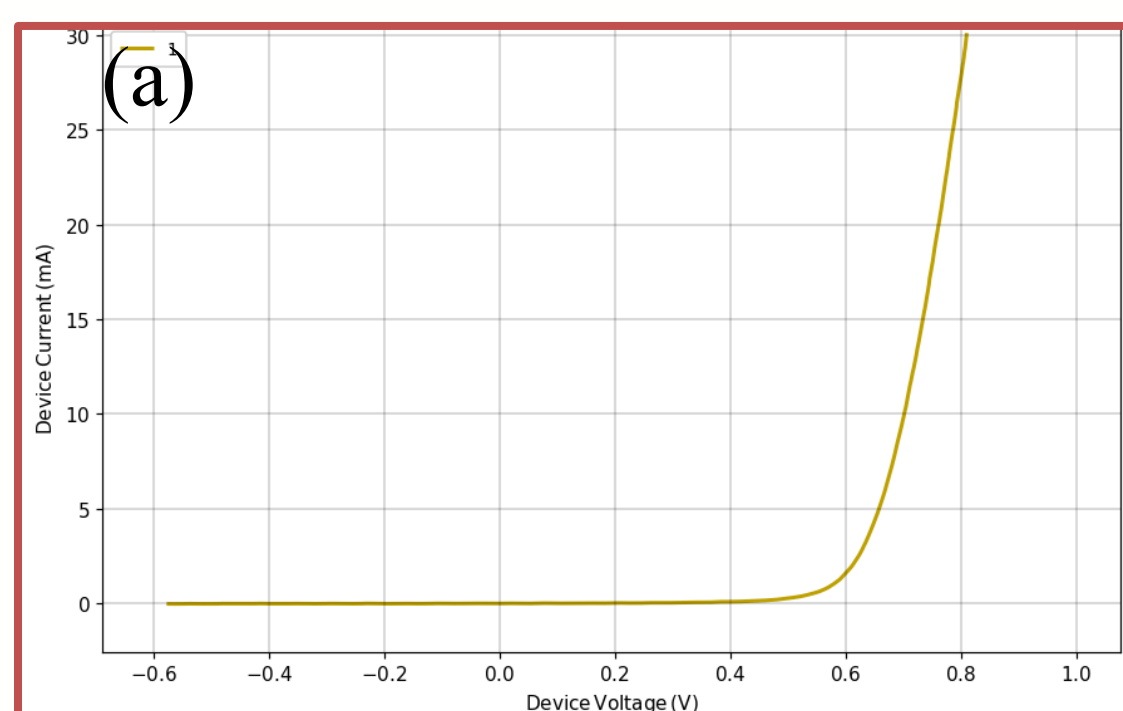


Figure 2a shows a JV curve of a silicon cell with an activation voltage of around 0.5.

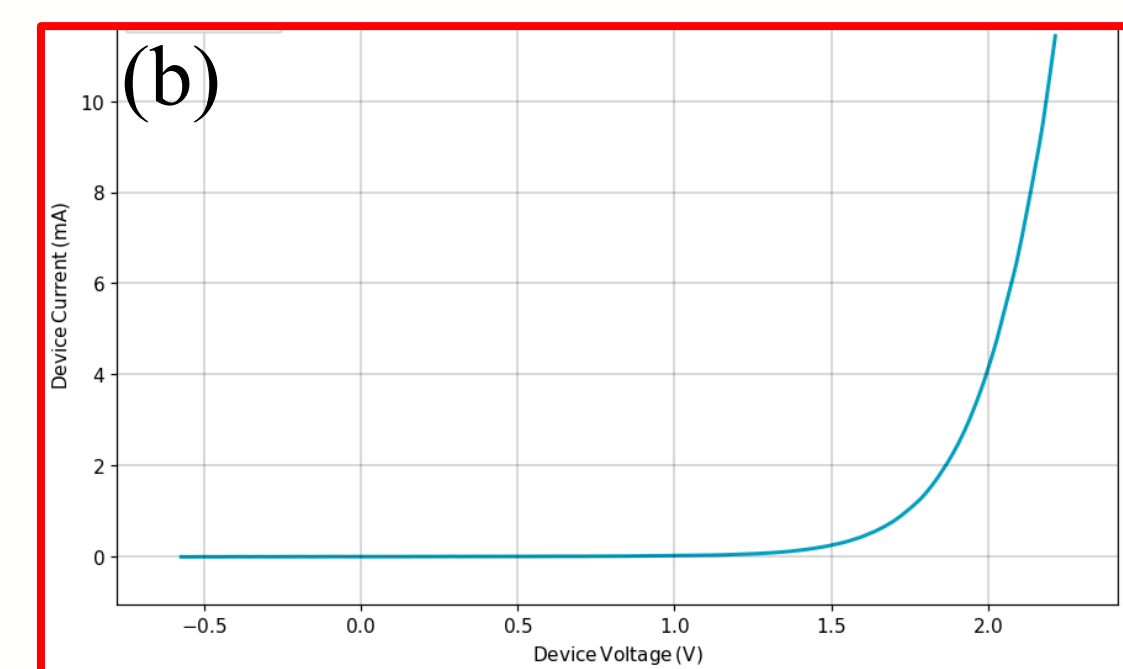
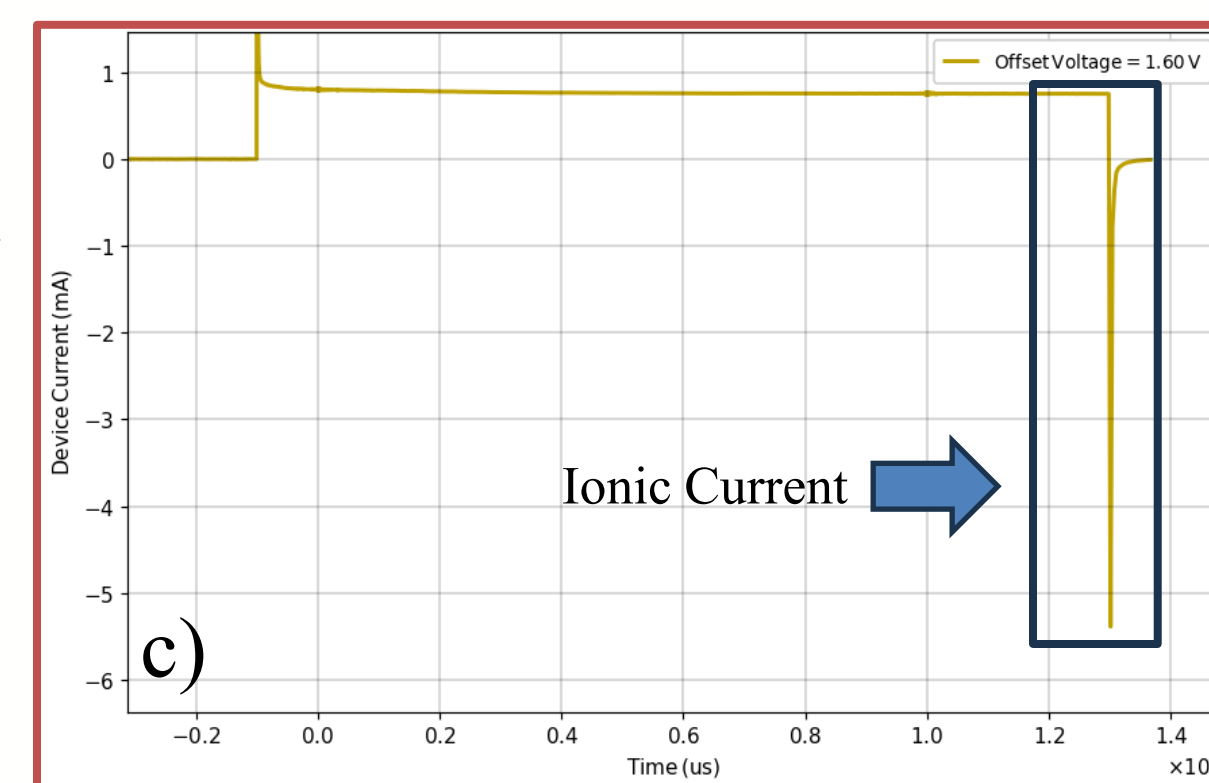


Figure 2b shows the tandem cell's JV curve with an activation voltage of around 1.5, indicating a higher potential power output in the tandem cell

Figure 2(a-c)



The TDC for the tandem cell is illustrated in Figure 2c, showing a dramatic drop in current, indicating a significant mobile ion redistribution.

Solar Cell	$N_0$ ( $\text{cm}^{-3}$ )
Perovskite	$(4.95 \pm 1.41) * 10^{18}$
Silicon	$(8.99 \pm 1.02) * 10^{17}$
Tandem	$(1.78 \pm 0.03) * 10^{19}$

Figure 3. Calculated Mobile Ion Concentrations

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