

# **Improved photovoltaic performance of a monolithic carbon-based perovskite solar cell under natural and various artificial lighting, highlighting additional light effects by using an optical WFL system**

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## **Abstract**

The performance of a photovoltaic system based on a monolithic carbon-based perovskite solar cell (PSCs), combined with light manipulation under natural and various artificial lighting using an optical water flow lens (WFL) system, is investigated. It was observed that efficiency becomes dominant at lower light intensities (23.8% at 25 mW/cm<sup>2</sup>, using xenon as a light source), and it becomes more significant when employing an optical WFL system under both low and high lighting conditions. Optical measurements at elevated light intensities, under standard test conditions (STC) and beyond, show a tendency for a linear or progressively linear correlation for certain light sources, indicating that while the current increases, the efficiency of the cell remains the same. However, these effects allow us to distinguish between the additional light effects (increase in current) that are always present and the characteristic behavior of the tested solar cells. The small changes measured, mostly in the red part of the light spectrum due to the use of the optical WFL system, cannot be solely responsible for the observed current increases. Some deviations in  $J$ - $V$  measurements at STC were noted depending on the artificial light source used, especially with a tungsten lamp. Nonetheless, the tested PSCs, as expected, followed the trend of higher efficiency at lower light intensities, regardless of the light source. Lifetime measurements at STC, with and without the WFL system under various artificial illumination conditions (halogen and xenon lights), revealed that the optics influence the greater stability of certain measured cell parameters.



