Increasing the Stability of Cost-Effective Perovskite Solar Cells Using a Novel Design with $BAPbI_3$ and Carbon

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In 2019, solar energy accounted for less than 2% of U.S. electricity production, as opposed to 62.7% from fossil fuels, according to the U.S. Energy Information Agency (EIA). In recent years, perovskite solar cells (PSCs) have risen in popularity due to their low cost and high efficiency, reaching 25.2% in 2019, thus rivalling silicon-based cells and helping promote the use of solar energy. However, PSCs remain extremely unstable. Furthermore, the widespread use of gold and Spiro-OMeTAD increases the fabrication cost. In this study, PSCs were specially designed to increase stability. This was done by utilizing the novel 2D/3D perovskite junction and using carbon as a hydrophobic layer. The configuration FTO/c-TiO_2/mp-TiO_2/perovskite/C was employed, with TiO_2 and perovskite layers applied through spin-coating followed by annealment, and carbon through thermal evaporation. The model PSCs maintained power conversion efficiencies (PCEs) of 7.73% for ~1000 hours when $BAPbI_3$ was used as a 2D perovskite layer on 3D $MAPbI_3$, and 7.49% for ~1000 hours when $PAPbI_3$ was used instead. The novel designs showed a 28% and 27% stability increase for the $MAPbI_3$/$BAPbI_3$ and $MAPbI_3$/$PAPbI_3$ samples, respectively, in comparison to pristine 3D $MAPbI_3$ PSCs. These results confirm that the proposed design demonstrates far greater stability in PSCs. Additionally, the fabrication cost was reduced by ~99.8% when gold and Spiro-OMeTAD were replaced with carbon. This model aids in closing the stability gap between PSCs and silicon-based cells, bringing PSCs closer to commercialization.