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Two-Dimensional Perovskite Heterostructures for Multifunctional Photonic Device Applications

Organometal halide perovskites are emerging materials for photovoltaics and light-emitting diodes (LEDs). Highest power-conversion efficiency (PCE) of three-dimensional (3D) perovskite solar cells is currently 23.3%, and the LED efficiency has reached 14.6%, but their low long-term stabilities under repeated operations are the main drawback to overcome for practical application and industrialization. As another issue, since the structure of the solar cell and LED is different from each other, the integration of their structures into on-chip device architecture enhances one performance but deteriorates the other, and vice versa. On the other hand, two-dimensional (2D) perovskites have recently received substantial attention due to their excellent stability and water resistance, much higher than their 3D counterpart [1-3]. Here, we report an interface-engineered perovskite 2D|3D-heterostructure to realize the multi-functional photonic device in on-chip, exhibiting PCEs of photovoltaics up to 20.7% under AM1.5, and external quantum efficiencies of LEDs up to 4.6%. This novel phenomenon is attributed to carrier transfer resulting in a high carrier density and enhanced carrier recombination at the 2D|3D interface, based on the structural, electrical, and optical characterizations.

References

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[2] D.H. Cao, C.C. Stoumpos, O.K. Farha, J.T. Hupp, M.G. Kanatzidis, J. Am. Chem. Soc. 137 (2015) 7843–7850.
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Figures

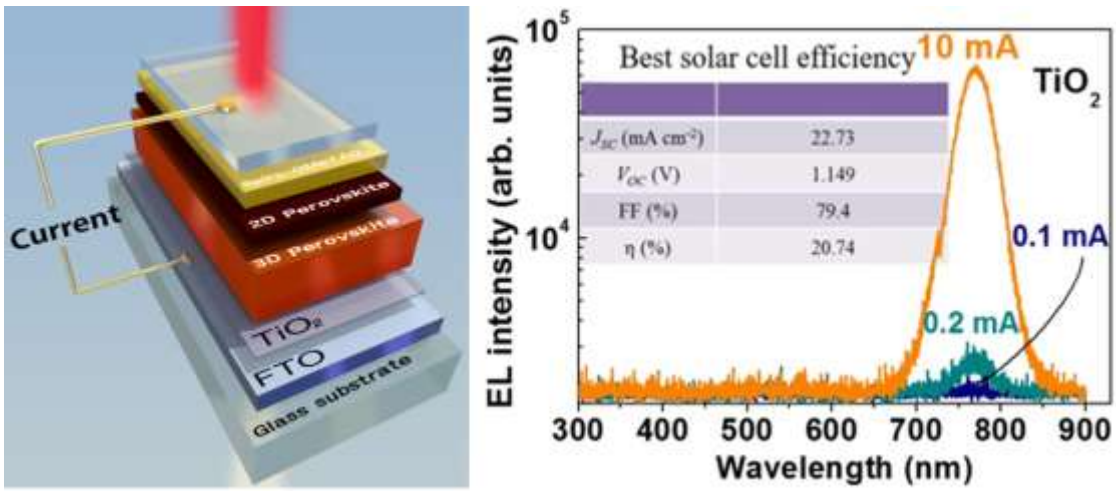

Figure 1: Photovoltaic and light-emitting properties of perovskite 2D/3D heterostructures.