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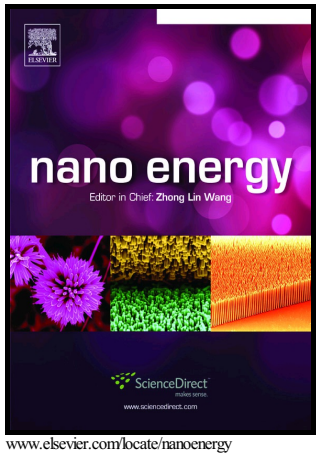

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17.46% efficient and highly stable carbon-based planar perovskite solar cells employing Ni-doped rutile TiO_2 as electron transport layer

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Abstract

Organometal trihalide perovskite solar cells (PSCs) with carbon counter electrode (CE) have attracted tremendous interest due to their remarkable properties such as low cost and high stability. However, carbon-based PSCs always suffer from much lower power conversion efficiency (PCE) than the counterparts with noble metal cathode. Herein, we demonstrate a carbon-based planar heterojunction PSC using high-crystallinity Ni-doped rutile TiO_2 as electron transport layer (ETL) for the first time, while copper phthalocyanine (CuPc) is introduced as hole transport layer (HTL). It is found that Ni doping can shift the Fermi level of the ETL upward and increase the charge mobility of the TiO_2 film, thus enhancing the charge transport and extraction. An optimized PCE of 17.46% was obtained after 0.01 M Ni doping, comparable to or even better than devices with state-of-the-art doped Spiro-OMeTAD as HTL and Au as CE. To the best of our knowledge, this is the highest efficiency that has been reported for carbon-based PSCs. By contrast, the pristine TiO_2-based device only displayed a PCE of 15.82%. Detailed superior capability of Ni-doped TiO_2 in facilitating charge transfer and suppressing carrier recombination are revealed by Hall effect and photoluminescence (PL) as well as electrochemical impedance spectroscopy (EIS) measurements. Furthermore, the use of highly stable CuPc and commercial carbon makes as-prepared PSCs exhibit excellent stability with no obvious decline in PCE after being stored in ambient air for 1200 h. This work presents an important step forwards to the

[1] Xingyue Liu and Zhiyong Liu contribute equally to this article.