

Enhanced fill factor for normal n-i-p planar heterojunction and mesoscopic perovskite solar cells using ruthenium-doped TiO₂ electron transporting layer

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The electron transporting layer (ETL) employed in such PSCs has been a critical component for improving their performance. The present work focuses on the synthesis of high-quality Ru-doped compact TiO₂ (c-TiO₂) ETLs (Ru:c-TiO₂) by a simple spin-coating technique. Further, the role of Ru⁴⁺ cation doping in c-TiO₂ is discussed in detail. A systematic study revealed that the Ru-doping not only significantly influences the open-circuit voltage (Voc), current density (Jsc), and fill factor (FF) but also suppresses the charge recombination in the perovskite devices. The PSCs prepared using Ru-c-TiO₂ ETLs with optimum Rudoping content exhibited PCEs of 19.48% for planar and 20.87% for mesoscopic device architecture with enhanced photovoltage. Additionally, the fabricated PSC devices based on 1.5% Ru:c-TiO₂ ETLs exhibited air stability over 200 days, which is much higher than that of a control device.