High efficiency all-solid-state dye-sensitized solar cells utilizing solution-processable inorganic semiconductors

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Dye-sensitized solar cells (DSCs) are low-cost photovoltaic devices that enable to convert sunlight to electricity with relatively high power conversion efficiency. They are promising alternatives to conventional solid-state solar cell technology based on materials such as Si, CdTe and $CuIn_{1-x}GaxSe_2$. However, the presence of organic liquid electrolytes critically limits long-term stability and performance because of their inevitable problems of leakage, high volatility and complex chemistry. In spite of significant efforts to replace liquid electrolytes, the efficiencies of the resulting DSCs remain low. Here we demonstrate that the p-type inorganic semiconductor $CsSnX_3$ (X = halogens or their mixtures) with remarkably high-hole-mobility can be solution-processed resulting in all-solid-state DSCs and replacing the problematic organic liquid electrolytes. $CsSnX_3$ compounds show direct bandgap at 1.3 eV and consist of inexpensive and earth-abundant elements. The resulting solid-state DSCs are made of $CsSnX_3$, nanoporous TiO_2 and the N719 Ru dye, and show power conversion efficiencies up to 10 per cent.