Tin oxide as a photoanode for dye-sensitised solar cells: Current progress and future challenges

Qamar Wali, Azhar Fakharuddin, Rajan Jose,
Nanostructured Renewable Energy Materials Laboratory, Faculty of Industrial Sciences & Technology, Universiti Malaysia Pahang, 26300 Kuantan, Malaysia

ABSTRACT

Tin oxide ($\text{SnO}_2$) is a candidate for applications requiring high electrical conductivity and optical transparency, such as a photoanode in dye-sensitised solar cells (DSSCs), due to its higher electron mobility and wider optical transparency than many other metal oxide semiconductors (MOS), such as TiO$_2$ and ZnO. However, DSSCs employing SnO$_2$ show significantly lower photoconversion efficiency, compared to that achieved by popular choices, such as TiO$_2$, due to its intrinsic limitations such as lower conduction band energy and isoelectric point. A survey of literature shows a revived interest in SnO$_2$-based DSSCs, for example, strategies to (i) increase the dye uptake, (ii) increase its Fermi energy level, and (iii) reduce the recombination, such as by increasing surface roughness and novel morphologies towards (i), and doping of transition metals for (ii) and (iii). In response to these improvements, SnO$_2$-based DSSCs showed similar open circuit voltage and superior short circuit current to that achieved by TiO$_2$. We have undertaken a critical review on the progress made in overcoming the limitations and capitalising the advantages of SnO$_2$ to fabricate more efficient DSSCs. We identify that more investment is required to reduce the recombination in SnO$_2$ for it to emerge as an efficiency record holder in DSSCs.

KEYWORDS: Electrochemical properties of SnO$_2$; One-dimensional SnO$_2$; SnO$_2$ composites; Doped SnO$_2$ nanostructures; Core–shell SnO$_2$ nanomaterials

DOI: 10.1016/j.jpowsour.2015.06.037