Abstract

The search for renewable and sustainable energy for energy security and better environmental protection against hazardous emissions from petro-based fuels has gained significant momentum in the last decade. Towards this end, energy from the sun has proven to be reliable and inexhaustible. Therefore, better light harvesting technologies have to be sought. Herein, the current trends in the development of perovskite solar cells with a focus on device engineering, band alignment, device fabrication with superior light harvesting properties, and numerical simulation of solar cell architectures are critically reviewed. This work will form the basis for future scientist to have a better scientific background on the design of highly efficient solar cell devices, which are cost-effective to fabricate, highly stable, and eco-friendly. This review presents thorough essential information on perovskite solar cell technology and tracks methodically their technological performance overtime. The photovoltaic (PV) technology can help to reduce pollution related to greenhouse gas emissions, criterion pollutant emissions, and emissions from heavy metals and radioactive species by nearly 90%. Following the introduction of highly efficient perovskite solar cell (PSC) technologies, the problems associated with stability, short life-time and lead-based perovskite solar cell configurations have significantly been minimized. The fabrication and simulation of perovskite solar cells has been made possible with advanced technologies and state-of-the-art computational codes. Furthermore, device simulation strategies have lately been used to understand, select appropriate materials, and gain insights into solar cell devices' physical behavior in order to improve their performances. Numerical simulation softwares such as the 1-dimenional solar cell capacitance simulator (SCAPS-1D), Silvaco ATLAS, and wx-analysis of microelectronic and photonic structures (wxAMPS) used to understand the device engineering of solar cells are critically discussed. Because of the need to produce charge collection selectivity, hole transport materials (HTMs) as well as electron transport materials (ETMs) constitute essential PSC components. In this work, the synthesis of inorganic HTMs, as well as their characteristics and uses in various PSCs comprising mesoporous and planar designs, are explored in detail. It is anticipated that the performance of inorganic HTLs on PSCs would encourage further research which will have a significant influence on the future designs and fabrication of highly efficient solar cells.