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Efficient semi-transparent perovskite solar cells with a novel indium zinc tin oxide top electrode grown by linear facing target sputtering

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HIGHLIGHTS

- High-quality IZTO film is deposited by linear facing target sputtering.
- The effect of thickness of the IZTO film on PeSCs performance was investigated.
- The IZTO-based semi-transparent PeSCs showed high efficiency of 12.85%.

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ABSTRACT

We propose that an indium zinc tin oxide electrode grown by linear facing target sputtering without additional thermal treatment can effectively act as an efficient semi-transparent top electrode for high-performance semi-transparent hybrid perovskite solar cells. The semi-transparent perovskite solar cells using an indium zinc tin oxide electrode as a novel top electrode achieves a power conversion efficiency of 12.85%, similar to that of an opaque electrode-based device of 13.48%. More importantly, by adjusting the perovskite thickness, a power conversion efficiency of 8.306% is obtained at an average visible transmittance of 33.9%, thus well supporting that the indium zinc tin oxide electrode can be considered to be an advanced and efficient semi-transparent top electrode for the fabrication of building integrated photovoltaics with high efficiency and good transparency.

1. Introduction

Organic-inorganic hybrid perovskites have emerged as the promising next-generation materials for the fabrication of highly efficient solar cells because of their excellent properties such as large absorption coefficients, large charge-carrier mobility, bipolar transport properties, and long carrier-recombination lifetime [1–9]. Recently, the power conversion efficiency (PCE) of perovskite solar cells (PeSCs) has achieved performance similar to that of the conventional photovoltaics based on silicon and thin-films [8]. Due to these perovskite's merits and value, the perovskite applications have been extended into the building-integrated photovoltaics (BIPVs), wearable electronics, and tandem solar cells [10–14]. In particular, the BIPV application has been highly attracted because the BIPV can be a major part of solar cell market and thus a transparent electrode essentially required for the top electrode has been increasingly important as a core material for the semi-transparent PeSCs. However, such semi-transparent electrode researches have not been relatively much studied, compared with the opaque or bottom electrodes. Therefore, development of an efficient semi-transparent electrode for fabricating semi-transparent PeSCs is of great importance for the BIPV application.

Various transparent electrodes, such as thin metal films, metal nanowires, conductive polymers, oxide/metal/oxide electrodes, and transparent conductive oxides (TCOs), have been so far reported and employed as the top electrode for semi-transparent PeSCs [14–27]. Among the various transparent electrodes, the silver-based materials including silver nanowires and silver thin films with metal oxides have been considered to be promising electrode alternatives for fabricating efficient semi-transparent PeSCs because of their advantages such as the solution processability, high conductivity, and high transmittance

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