School of Photovoltaic and Renewable Energy Engineering

Bi-functional encapsulant for stable tandem perovskite solar cells

What we do: Improving the stability of perovskite solar cells via bi-functional encapsulant (Australian Patent no. 2016904145)

Perovskite solar cells (PSC) are the "fastest" growing photovoltaic technology ever till date. Perovskites possess properties similar to inorganic semiconductors and exhibit sunlight-to-electricity conversion efficiencies greater than 22%. However, the commercial readiness of this technology is limited by the stability or lifetime issues. The preparation of PSC modules having adequately long operating lifetimes for their intended end-use remains a major challenge. Developing encapsulation technologies to limit the exposure of PSCs to moisture and oxygen is imperative. Therefore, we have developed an innovative approach to employ bi-functional inorganic encapsulant materials to solve the degradation issues resulting from moisture and oxygen ingression.

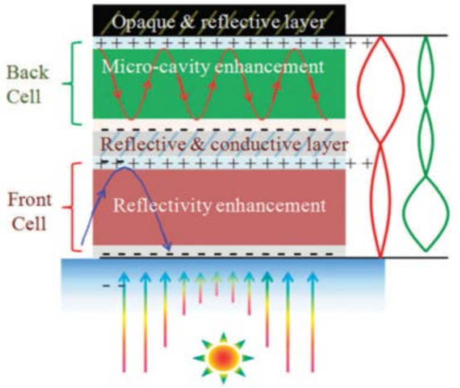

Fig. Schematic device structure of Perovskite (Front cell) with bi-functional encapsulation (back cell) tandem solar cell in series connection to solve the degradation issues resulting from moisture and oxygen.

The proposal is for a bi-functional back cell material, which acts both as an encapsulant to protect the perovskite front cell and as an active back solar cell in a tandem structure. This requires an inorganic heterojunction type cell of approximately 1.1eV. It is also important that is a low temperature, solution processable material in order not to damage the front aide perovkite cell which is deposited first. A highly sutable inorganic material and heterojunction device structure has been identified, which is also solaution processable at about 140°C.

The interconnect between the front and back cell will incorporate a novel multifunctional interconnection layer (ICL) which not only facilitates a tailored cascade energy arrangement for efficient electrical connection between the sub-cells, but can also provide effective optical manipulation between them via the micro-cavity derived from the embedded ultra-thin Ag (5–10 nm) as shown in above Figure. Ideally, most of the high energy photons should be reflected by this ultra-thin Ag layer while the transmitted low energy photons should be effectively confined in the back sub-cell *via* the micro-cavity effects. The proposed design with the multi-functional interconnection layer (ICL) is highly versatile i.e. any perovskite (light absorbing) material of band gap higher than the band gap of the encapsulating top cell can be introduced in the bottom cell.

The expertise of the team involved in this proposal matches aptly with the requirement of the project both from device engineering as well as from the electronic characterization perspective. Moreover, the experience of the team in electronic device and optical design should allow further improvement particularly in relation to improved photovoltage, by carrier recombination suppression and improved current by efficient photon accounting.

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