Ferroelectric Oxide/Halide Perovskite heterojunctions: application as solar cells and solar transistors

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Metal halide perovskite materials exhibit exceptional performance characteristics for low-cost optoelectronic applications[1] . State-of-the-art halide perovskite solar cells (PSCs) employ semiconductor oxides as electron transport layers (ETL) for example, TiO_2[2][3][4]. This oxide, under UV irradiation and Oxygen, directly affects the stability of the solar cells, owing to the defects such as Oxygen vacancies (O_{vac}). In this work, we demonstrate the application of Ferroelectric oxides such as $PbZrTiO_3$ (PZT) and $BiFeO_3$ (BFO), as the electron extraction material in halide perovskite solar cells. The application of a bias voltage (poling) up to 2 V, under UV light, is a critical step to induce charge transport in these materials[5]. For PZT, champion cells result in power conversion efficiencies of ~13% after poling. Stability analysis, carried out at 1-sun AM 1.5 G, including UV light in air for unencapsulated devices, shows negligible degradation for hours[6]. For BFO, the solar cells reach a maximum efficiency of around 4 % which is the highest efficiency reported up to date for this type of devices. For BFO, the stability analyses carried out inside a nitrogen chamber under continuous light irradiation at 1 sun show reversible switching properties with a typical T_{80} (time at which it reached the 80 % of the initial efficiency) of around 180 mins. Our results were supported by characterization analysis with XRD, XPS, AFM, IPCE, UV-vis spectroscopy, photoconductivity techniques apart from J-V curves. In conclusion, we introduced ferroelectric oxides as ETL and successfully incorporated into solar cells, giving better UV and moisture stability for PZT based solar cells compared to BFO based solar cells. The switching property of our devices permits also their application as solar transistors, which is a step forward applications in self-power electronics for the future IoT [7].

References

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Figures

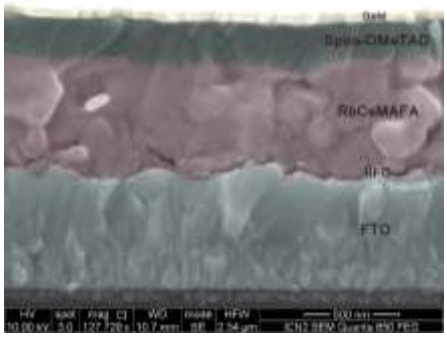

Figure 1: Cross-sectional SEM view of a typical Perovskite solar cell applying the BFO as the electron transport layer.