Title: Bifacial perovskite solar cell and device physics of its light induced degradation

Abstract:

Perovskite solar cell has attracted great attention recently because of its great potential to be high efficient photostatic. Being the top cell of a perovskite-silicon tandem solar cell is one of perovskite’s most importance applications. In order to do that, the perovskite layer has to be sandwiched by two transparent layers, which makes the device a bifacial solar cell. In this project, we successfully made a bifacial perovskite solar cell by depositing CdS:In and ZnO:Al on top of perovskite. The CdS:In buffer layer effectively protects perovskite from plasma attacking during ZnO:Al sputtering. By optimizing the thickness of CdS:In, we achieved 14+% efficiency with light coming either from the top or bottom. This was the second best bifacial perovskite solar cell in the field at that time. The ZnO:Al layer also provides a great encapsulation to protect perovskite, which greatly improves the perovskite lifetime in ambient air from less than 20 minutes to more than 3 months.

As the top cell of perovskite-silicon tandem, the photo-stability of perovskite layer is extremely important. Systematic experiment and detailed device data analysis are performed to understand it degradation mechanism. The photo-induced degradation data of perovskite solar cell tells us that its degradation mechanism is much different from that of a-Si and organic solar cells. We found that the degradation of perovskite under light exposure is attributed to the generation and migration of ions. We proposed an ion-generation-migration model which explains every device behavior during the degradation and recovery process of perovskite solar cell. Quantitative relationship between performance degradation and ion density is investigated by transient ionic current measurement. We also provided two approaches to mitigate photo-induced degradation. By increasing the grain size or adding excess PbI2, the degradation is retarded by 50% respectively. The ion density we calculated from transient ionic current also shows significant reduction by applying those approaches.