Improvement of Perovskite Solar Cell Efficiency through PLA Additive Induced Boundary Passivation with Application of Machine Learning in Crystal Image Analysis

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Perovskite solar cell power conversion efficiency (PCE) has rapidly improved, however, solar cell disposal is projected to release over 78 million tons of toxins such as cadmium and lead, annually by 2050. Remedying this issue is of paramount importance. Perovskite solar cells pose a promising solution due to their rapid improvement in PCE in recent years. With the goal of improving sustainability and efficiency, a biodegradable PLA additive was hypothesized to augment these characteristics. In this study, two PLA additives, 30K PLA and 16K PLA, were used. These additives unanimously increased the PCE of perovskite solar cells across various concentrations. Additionally, perovskite crystal size is positively correlated with cell efficiency, so a machine learning algorithm was developed to autonomously compute size distributions of PLA-modified perovskite crystals from SEM images. This procedure showed that both the 30K and 16K PLA increased the average size of the crystal grains ($p<0.05$) through a PLA and PbI2 complex. These complexes passivated the boundaries between crystal grains, decreasing the number of dissoluted excitons by redirecting them in the direction of the current. By varying only concentration or molecular weight, I discovered an optimal combination of 0.3 mg/mL and 30,000 amu. Given the observed improvement in efficiency of up to 23% and X-Ray Diffractometry data indicating that the PLA samples reduced the rate at which toxic chemicals are released by up to 25%, my method of augmenting the efficiency and sustainability of perovskite solar cells holds promise for being a green solution to the waste crisis.

Awards Won:

Third Award of $1,000