Hysteresis, Stability and Reproducibility Challenges in Perovskite Solar Cells

Talk 1: Hysteresis, Steady state Performance, Performance Degradation and Recovery in Perovskite Solar Cells

Speaker: Ajay Kumar Jena
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Abstarct: Despite an expeditious rise in its power coversion efficiency organolead halide perovskite solar cells (PSCs) still stand way behind commercialization because of two major challenges; poor stability and high toxicity of Pb. In additon, the J-V hysteresis and performance reproducibility challenges observed in the perovskite solar cells have been constant concerns. Some studies related to these issues and our unserstanding based on the results will be shared in the scheduled talk. The content of discussion will essentially address the following questions; (1) Is hyseresis caused by ferroelectric peroperty of perovskite? (2) Does hysteresis affect steady state performance and peroformance stability? (3) Is degradation of perovskite the main reason of performace deterioration in perovskite solar cells at elevated temperatures? (4) Can the degraded perovskites be recycled or reused without disposing the Pb and thus, avoiding lead toxicity?

Talk 2: Thermally stable methylammonium-free perovskite solar cells

Speaker: Youhei Numata
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Abstract: Both thermal and chemical instability of perovskite solar cells (PSCs) have been two serious problems to realize commercial use of PSCs. By means of mix cation and/or halide perovskite, 2-D–3-D mixture and other techniques, inherent stability of perovskites has been significantly improved. Above methods are based on two strategies; 1st is to improve stability of perovskite (enthalpically) by mixing cation and halogens, and 2nd is passivation of perovskite surface by replacing bulky cations such as butylammonium, which behaves as barrier against moisture. One of the largest problems of the instability is ascribed to methylammonium (MA) because of its volatility (b.p. = –6 ℃); therefore, it is expected that MA-free perovskite exhibits higher stability. Based on this expectation, we have developed various MA-free perovskite and their PSCs by means of formamidinium (FA) and alkali metal ions; Cs and Rb. Using non-volatile FA ion, stability of the perovskite was improved; furthermore, by addition of Cs and/or Rb ion, not only stability but also conversion efficiency was improved up to 20%..

Talk 3: The Importance of Regulating Evaporation Kinetics of DMSO for Mixed Cation/Halide Perovskites

Speaker: Gyu Min Kim
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Abstract: Despite the popular use of anti-solvent treatment (AST) nowadays, the biggest concern still remains about reproducible fabrication of mixed cation/halide perovskites. Optical and electrical properties of mixed cation/halide perovskites often show incoherent results even under the precisely controlled environment by regulating humidity and oxygen level. Here, we focused on the DMSO-related intermediate phases and solvent evaporation kinetics. As we have found, there are approximately six different states after anti-solvent dripping and any perovskite can belong to one of them. We observed that the change of optoelectronic properties of perovskites was conspicuous by evaporation kinetics of DMSO for only two states among six while its effects are marginal for other four states. This phenomenon emphasizes the fact that adequate control of DMSO for mixed cation/halide perovskite precursors with certain compositions is of great importance for further photovoltaic performances to minimize experimental errors. Through the optimization of evaporation kinetics of DMSO, mixed cation/halide perovskite solar cells (PSCs) recorded 21.3% of power conversion efficiency (PCE). Further, certified 18.3% of PCE was also obtained for the planar-typed PSCs with large active area (1 cm^2).