Innovative In-situ Processing of Perovskites

K. Bruening[1], Vanessa Pool[1], Michael F. Toney[1], Christopher J. Tassone[1]

[1] Stanford Synchrotron Radiation Lightsource, SLAC National Accelerator Laboratory, Menlo Park, USA

Lead halide perovskites have received an enormous interest by the scientific community over the last five years, triggered by the unprecedented rise in performance of perovskite-based photovoltaic cells. Power conversion efficiencies now exceed 22% and 20% PCE devices with stable performance under IEC 61646 over 1000h accelerated lifetime testing have been reported.
With the technology gaining maturity and approaching commercialization, transition from the lab scale to pilot scale is an active field of research.
We built a blade coating device to cast perovskite films in situ. Blade coating is a scalable technology and allows to monitor all stages of the film formation process in-situ at the beamline. Furthermore, we use a custom-made in-situ flash annealing chamber to convert the perovskite precursor to the perovskite film. Conventional conversion protocols involve a low temperature heating step around 100°C for about 2h, which is not industrially viable. The flash annealing chamber brings down the conversion time to 5s, while improving the film quality and maximizing the grain size.
Given the large parameter space (print speed; solution temperature, concentration and composition; drying and conversion temperature profile, etc.) and the lack of transferability of spin coating recipes to blade coating, following the film formation and conversion in situ at the beamline can drastically reduce the time to optimize the processing conditions for fabricating high quality perovskite films. Furthermore, we obtained fundamental insight into the kinetics of precursor crystallization and perovskite conversion.