TEM analysis of photoactive perovskite nanomaterials and devices

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Hybrid perovskites have attracted attention for their promising behaviour in optoelectronics. LEDs and solar cells based on these nanomaterials can be produced and processed at low costs, and can achieve power conversion efficiencies. Hybrid perovskites tend to be sensitive to the environment, as well as applied electric fields, and can rapidly degrade due to ionic migration – which in turn has severe ramifications for their device performance and stability. Although much progress has been made on establishing the impact of different stimuli on their performance, the nanoscale behaviour of these composite devices is still under investigation. We apply scanning transmission electron microscopy (STEM) techniques to study the local variation in composition and structure due to fabrication processes and external stimuli, with a combination of dark field imaging and energy dispersive X-ray spectroscopy (EDX).

We developed approaches to study hybrid nanostructured devices, including FIB device cross-sectioning, compositional mapping and multivariate statistical analysis for low electron dose acquisition to reduce beam damage effects on sensitive materials. These studies have revealed how the hybrid materials respond to applied electric fields, incident light and/or electrical injection, not just across the photoactive layers, but also in the charge-selective thin films that are used to improve device stability.