Is it possible to identify solar illumination-induced phase segregation in perovskite thin-film solar cells absorber by hard x-ray photoelectron spectroscopy?

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It has been observed that in methylammonium lead and cesium lead bromide-iodide perovskite solar cells the V_{OC} of the device increases with the band gap of the absorber, which increases with bromine concentration, up to a certain saturation point. The V_{OC} then cannot be increased further until a pure bromide perovskite absorber is used, at which point the V_{OC} attains the expected value. It is believed that in certain cases this behavior is related to illumination-induced phase segregation - the so-called "Hoke Effect." Aiming at studying this effect, we have measured $CH_3NH_3Pb(Br_{0.75}I_{0.25})_3$, $CsPb(Br_{0.75}I_{0.25})_3$, and $CsPb(Br_{0.5}I_{0.5})_3$ films on FTO using hard x-ray photoelectron spectroscopy (HAXPES) before, during, and after illumination. Focusing on the spectral changes in the core level and valence band HAXPES spectra, we hope to gain insight into related changes in chemical and electronic structure. In our contribution, we compare the composition dependence of our results to published observations of the effects and likelihood of illumination-induced phase segregation.