

Figure S1. Transient photoluminescence of perovskite on glass prepared under different atmospheres.

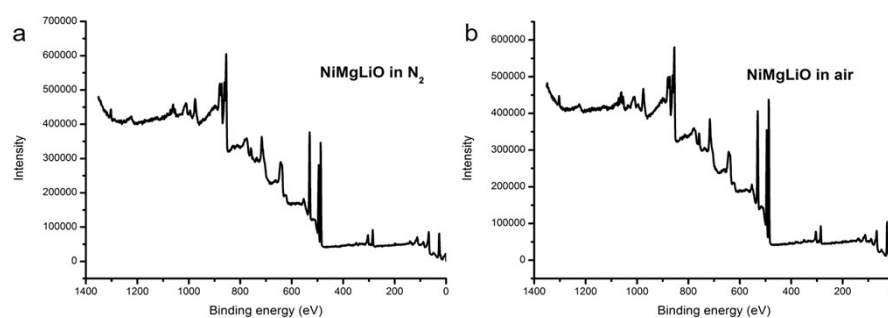


Figure S2. Survey spectra of NiMgLiO films annealed under different atmospheres.

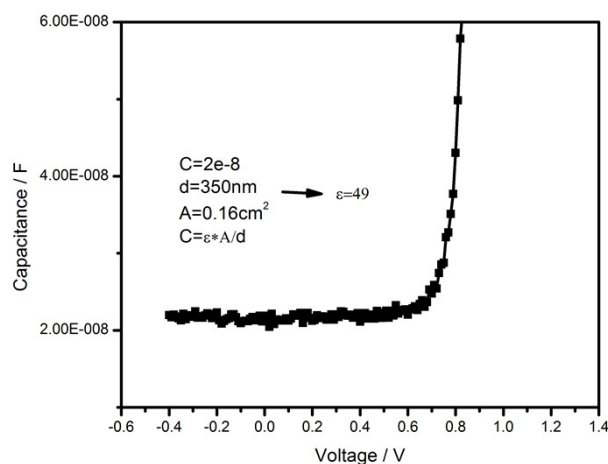


Figure S3. Dielectric constant derived from C-V measurement.

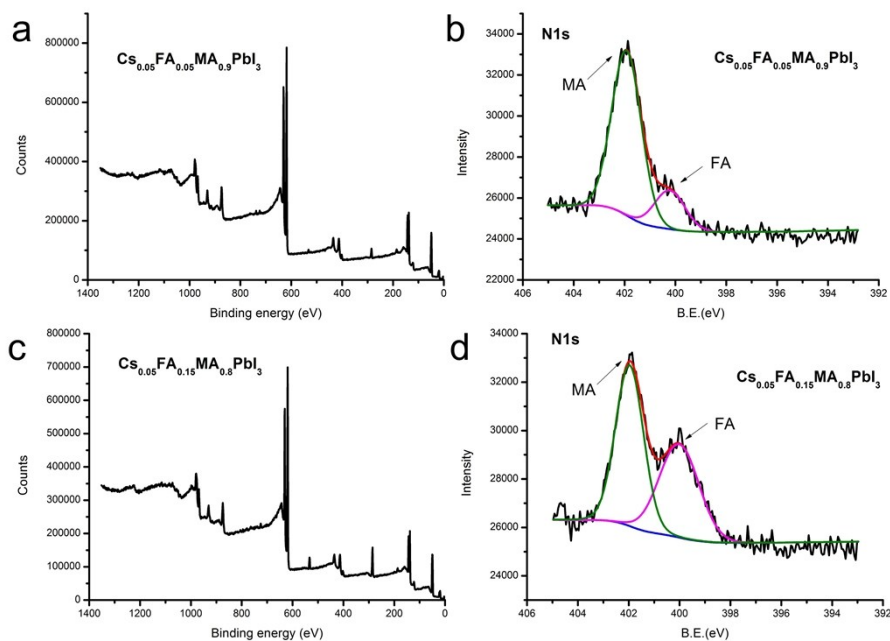


Figure S4. XPS spectra of $\text{Cs}_{0.05}\text{FA}_x\text{MA}_{0.95-x}\text{PbI}_3$. (a) Survey spectra of $\text{Cs}_{0.05}\text{FA}_{0.05}\text{MA}_{0.9}\text{PbI}_3$ film. (b) N1s spectra of $\text{Cs}_{0.05}\text{FA}_{0.05}\text{MA}_{0.9}\text{PbI}_3$. (c) Survey spectra of $\text{Cs}_{0.05}\text{FA}_{0.15}\text{MA}_{0.8}\text{PbI}_3$ film. (d) N1s spectra of $\text{Cs}_{0.05}\text{FA}_{0.15}\text{MA}_{0.8}\text{PbI}_3$.

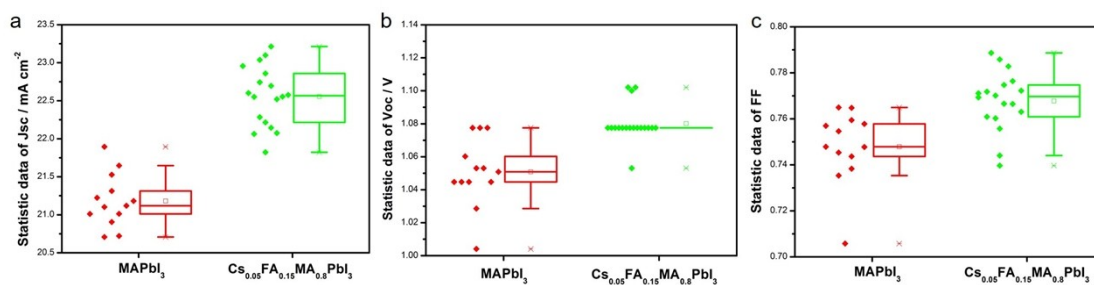


Figure S5. Statistic values of the fabricated perovskite solar cells. (a) J_{sc} , (b) V_{oc} , (c) FF.