

Figure S1. XPS spectra of (a) F 1s for COTIC-4F thin film, COTIC-4F-treated perovskite thin film and (b) Cl 2p for COTIC-4Cl thin film, COTIC-4Cl-treated perovskite thin film

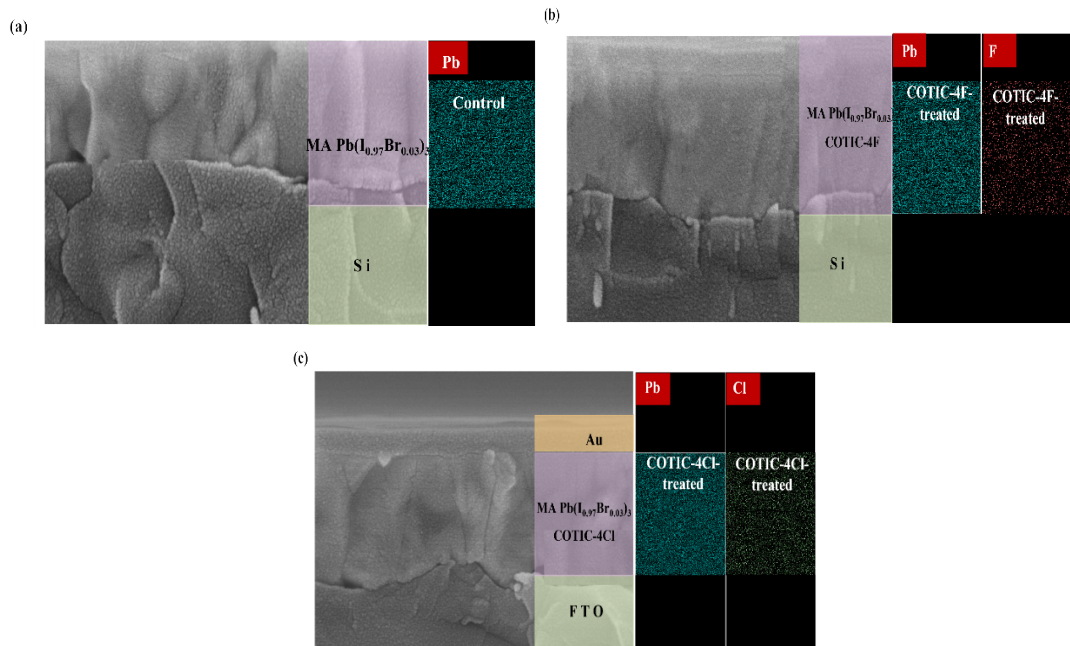


Figure S2. Cross-sectional SEM images and the EDX element mapping images of the PSCs: (a) control thin film, and (b) COTIC-4F-treated thin film, (c) COTIC-4Cl-treated thin film.

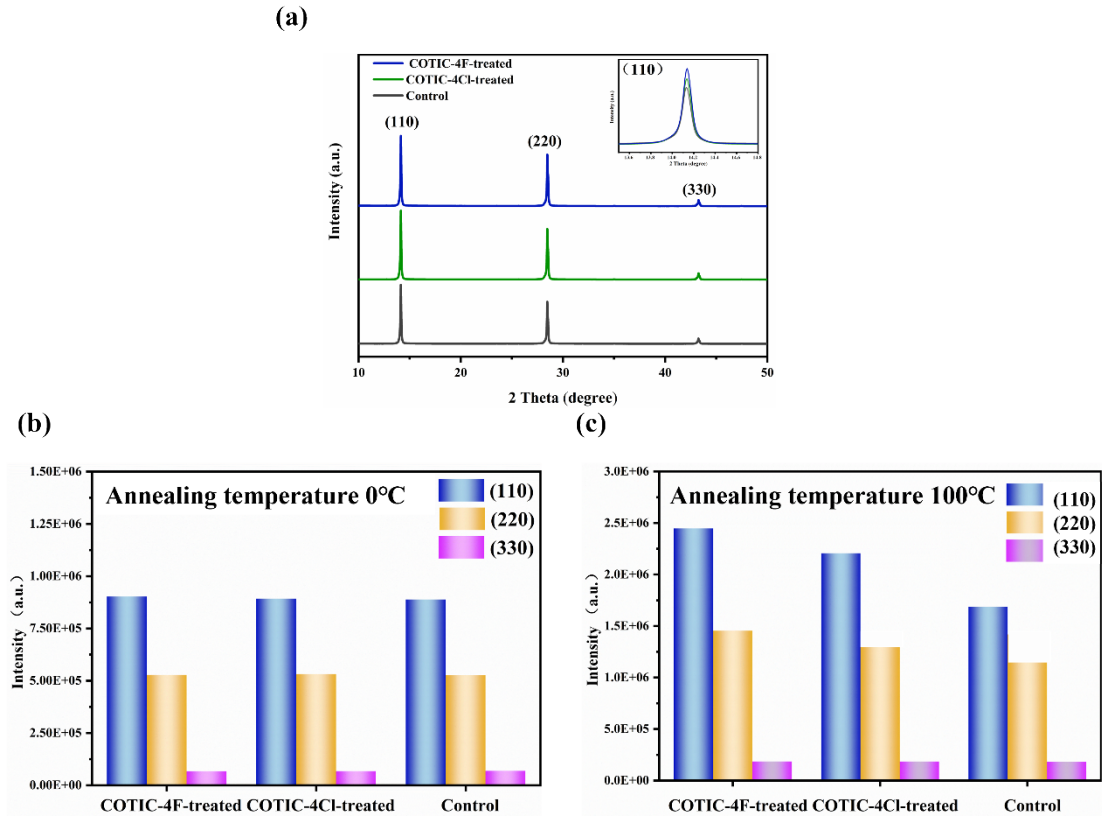


Figure S3. (a) XRD spectra of control thin film (black), COTIC-4F-treated thin film (blue) and COTIC-4Cl-treated thin film (green). (b) and (c) The intensity transformation of (110), (220) and (330) peak for control thin film, COTIC-4F-treated perovskite thin film and COTIC-4Cl-treated perovskite thin film.

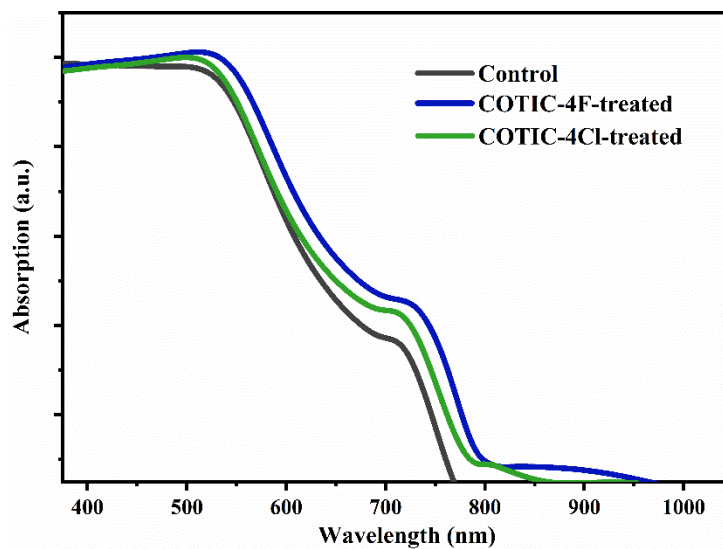


Figure S4. UV-vis absorption spectra of Control thin film, COTIC-4F-treated thin film and COTIC-4Cl-treated thin film.

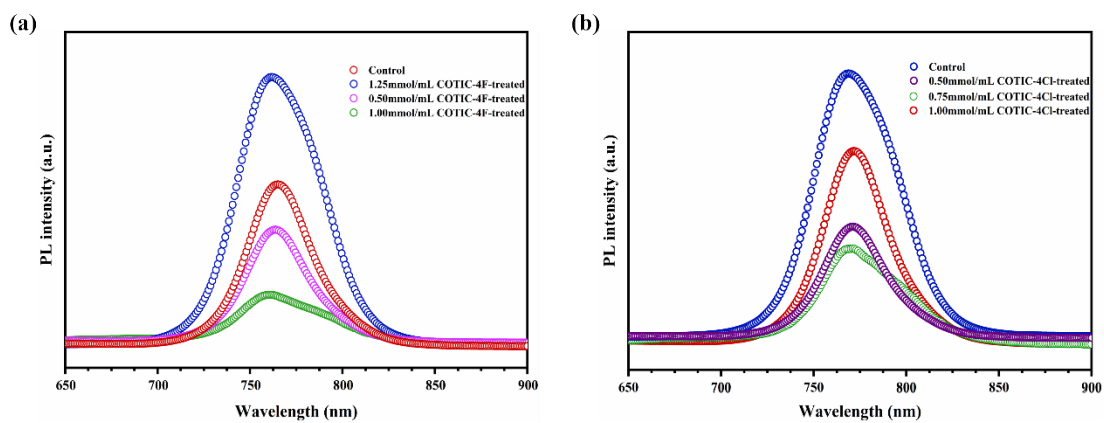


Figure S5. (a) Steady state PL spectra of control thin film and COTIC-4F-treated at different concentrations; (b) Steady state PL spectra of control thin film and COTIC-4Cl-treated at different concentrations.

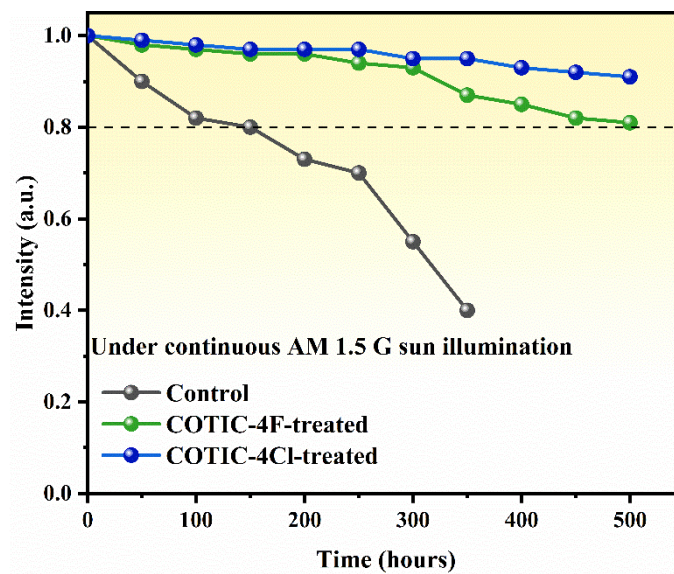


Figure S6. Light stability under continuous AM 1.5G sun illumination for control thin film, COTIC-4F-treated and COTIC-4Cl-treated thin film in ambient atmosphere and room temperature.