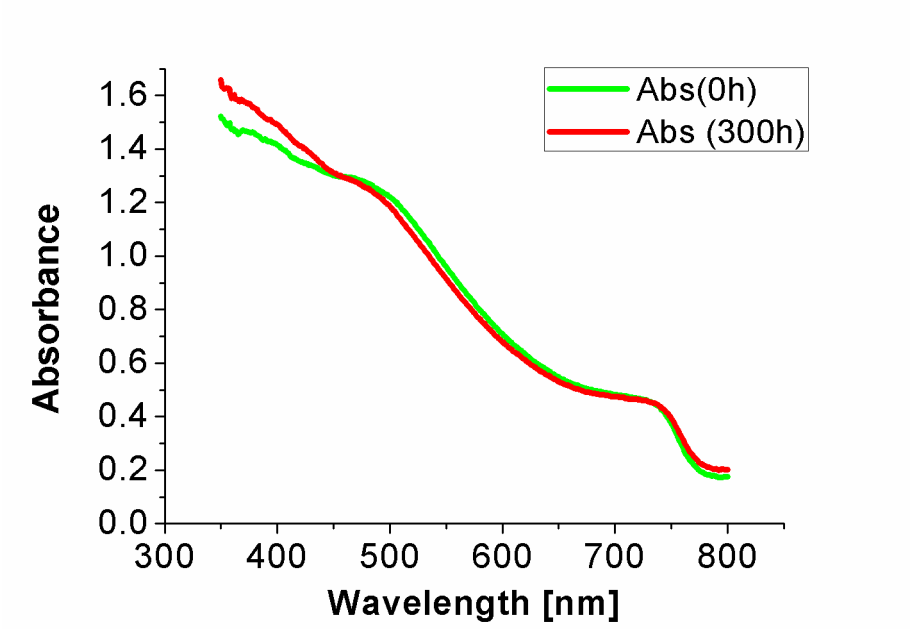
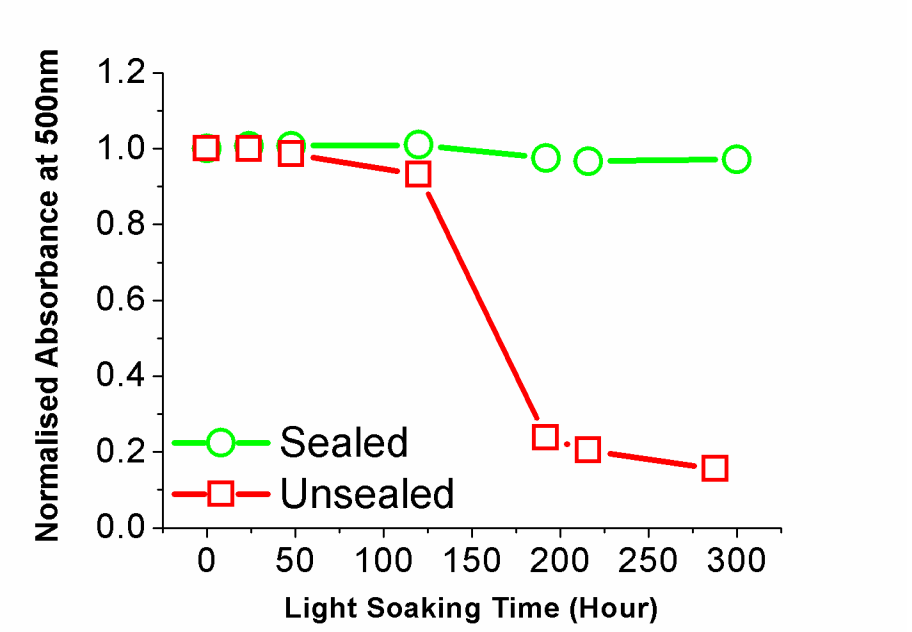
Perovskite Optical Stability Test

The Optical long-term stability of the FTO/TiO_2/$CH_3NH_3PbI_{3-x}Cl_x$ was tested under standard illumination conditions (AM1.5 Class A Light Soaker 1 Sun at 40 °C in air) maintained at Voc condition. The sealing procedure, described in the experimental section of the manuscript, was performed under inert atmosphere in glow box . To test the stability of the perovskite-layer, the $CH_3NH_3PbI_{3-x}Cl_x$ perovskite was deposited on the 4cm^2 titania scaffold (thickness 700nm) with the same deposition procedure used in the case of module. Subsequently, the device was sealed with a thermoplastic sealant over the whole scaffold area at 90°C and a secondary sealant (cyanoacrylate glue) was applied on the edge of the protective glass. The absorbance spectrum of FTO/TiO2/$CH_3NH_3PbI_{3-x}Cl_x$ was continuously monitored during the light soaking test for about 300 hours illuminated at 1 Sun with a class A light soaker where the temperature was kept constant at 40°C with a chiller (Solaronix, model. SOLARTEST 65- STF65). As shown in the below figure, comparing the absorbance spectra of a fresh sample with the same sample after 300 hours of light soaking test, little variation of absorbance was observed.



Absorbance spectra of $CH_3NH_3PbI_{3-x}Cl_x/TiO_2$ device sealed with thermoplastic sheet before (green curve) and after (red curve) light soaking test of 300hours at AM1.5G illumination conditions under Class A Light Soaker at 40°C in air.

Fixing the wavelength at 500nm, corresponding to the maximum value of IPCE spectrum, it is possible to monitor the optical long term stability of the $CH_3NH_3PbI_{3-x}Cl_x$ perovskite. The below figure shows an excellent stability of the $CH_3NH_3PbI_{3-x}Cl_x$ optical properties when illuminated at 1 Sun (Sealed device, green curve, relative variation below 4%). This kind of optical characterization is already reported from M.M. Lee at al. in the case of unsealed device illuminated under inert conditions [13]. As shown in figure below, the sealing procedure is necessary to obtain the optical stability of the perovskite when the light soaking is performed in air environmental condition. Instead, un-encapsulated sample degrades relatively quickly.



Evolution of the normalized absorbance at 500nm after 300 hours of Light Soaking test in the case of unsealed (red curve) and sealed device (green curve). The device structure was FTO/TiO2/ $CH_3NH_3PbI_{3-x}Cl_x$, the perovskite layer was deposited with same deposition parameters used in the module.

In conclusion, we have demonstrated the optical stability of Perovskite/Titania device but we don't investigate the electrical stability of perovskite in terms of its ambipolar transport properties. A more complete characterization will be reported in future studies.