Electronic Supplementary Material (ESI) for Physical Chemistry Chemical Physics.

Humidity versus photo-stability of metal halide perovskite films in a polymer matrix

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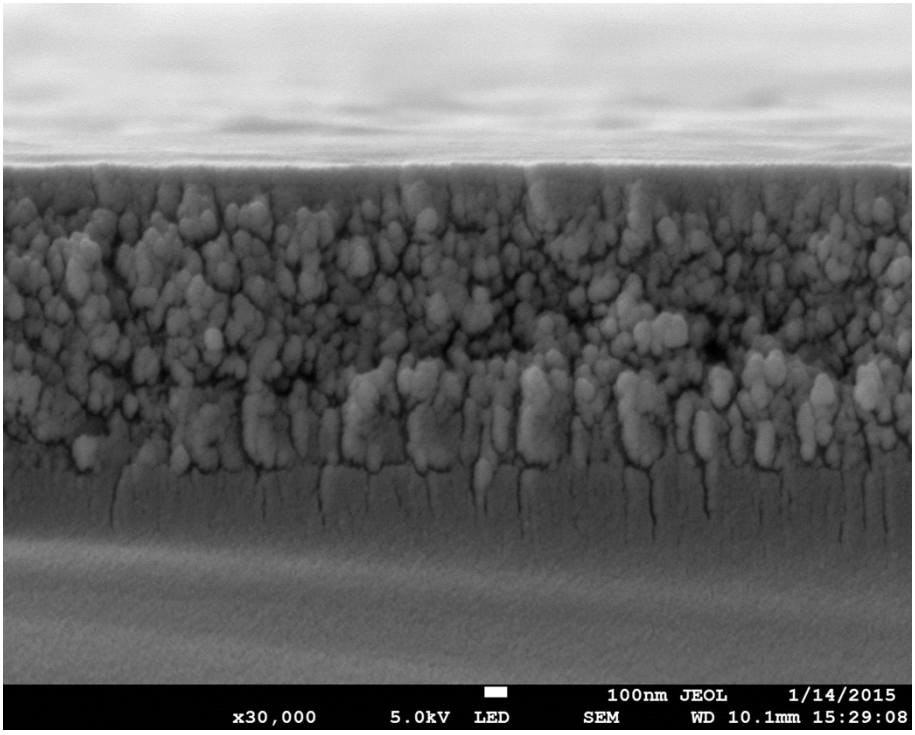

Figure SI 1: Cross-sectional micrograph of a perovskite film developed in glove box. Figure taken from our past report with permission.[1]

PL spectra of perovskite films on TiO_2 coated glass substrates.

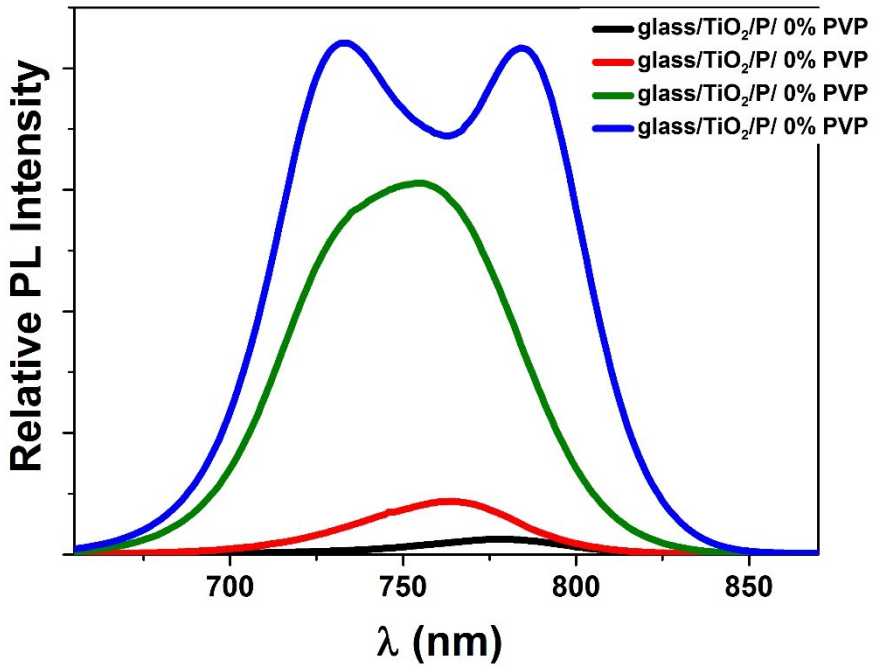

Figure SI 2: PL spectra of perovskite film on a TiO_2 coated glass substrates to quantify optical quenching of the four films.

Absorbance in dark

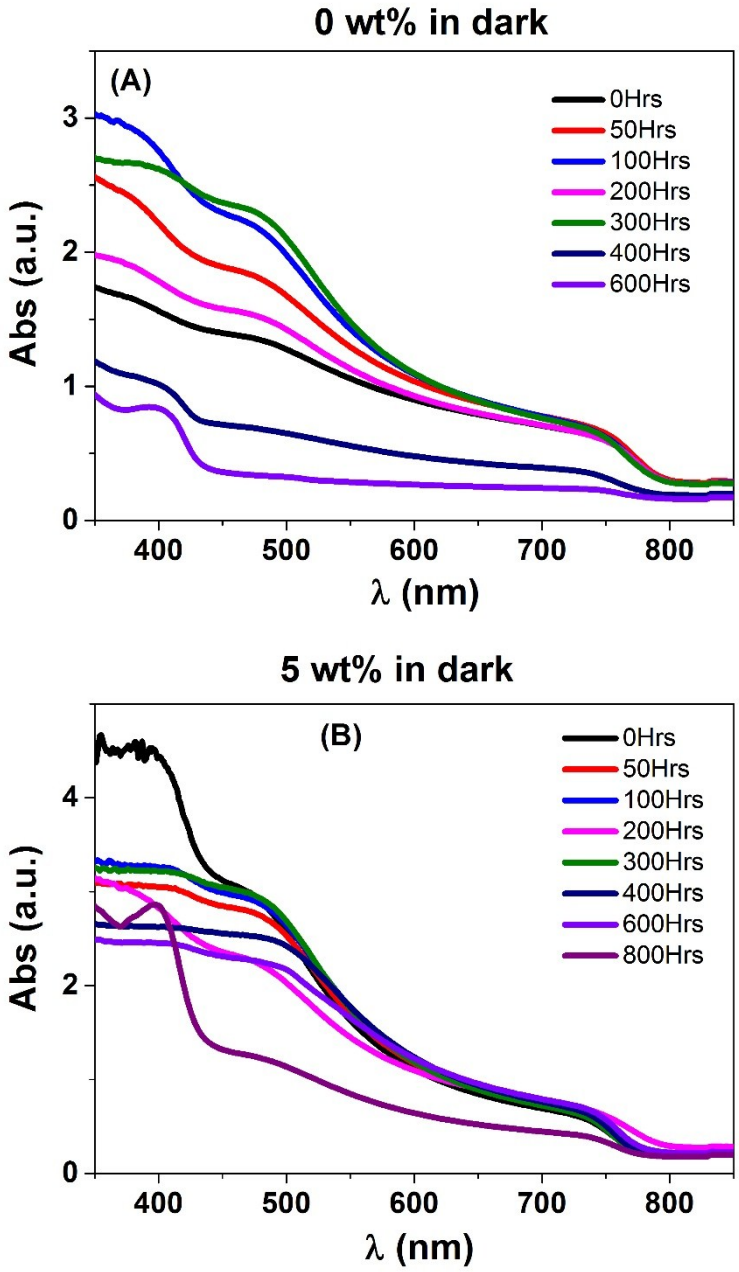

Figure SI 3: Absorbance spectra of 0 and 5 wt.% PEP films in dark (a & b).

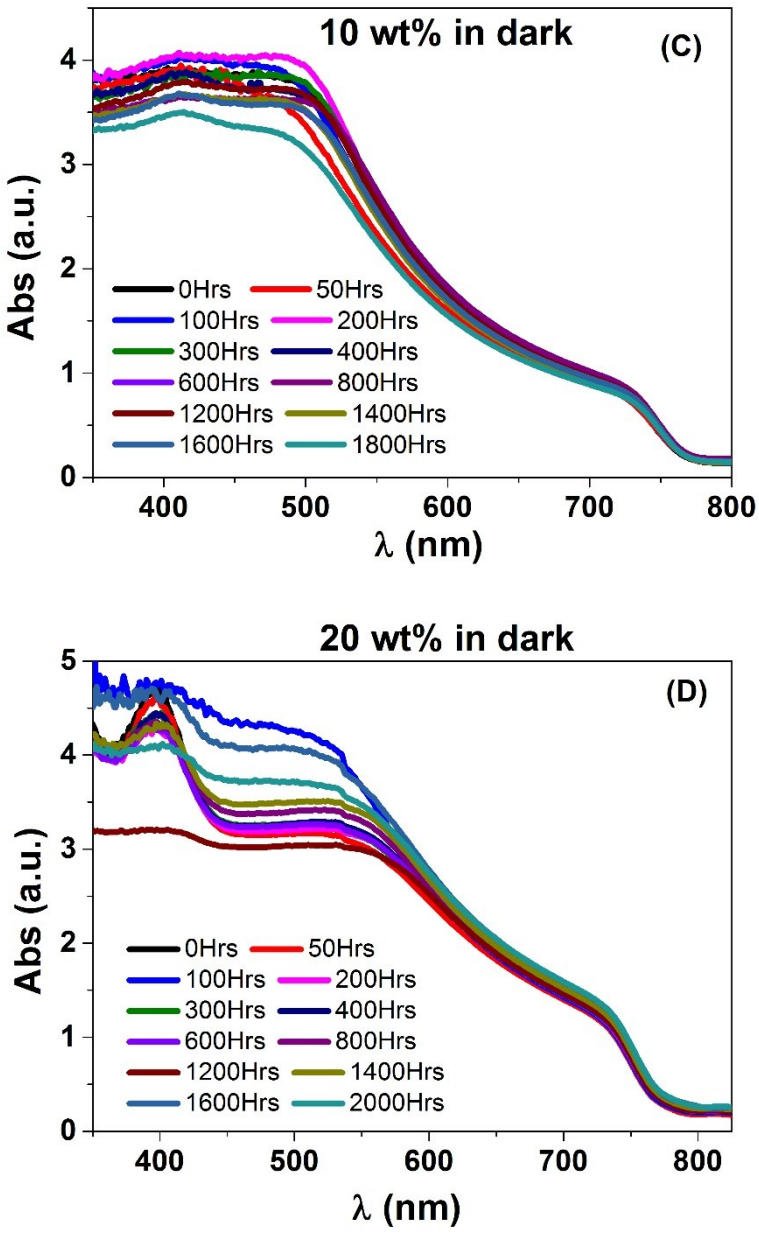

Figure SI 3: Absorbance spectra of 10 and 20 wt.% PEP films in dark (c & d).

Absorbance in light

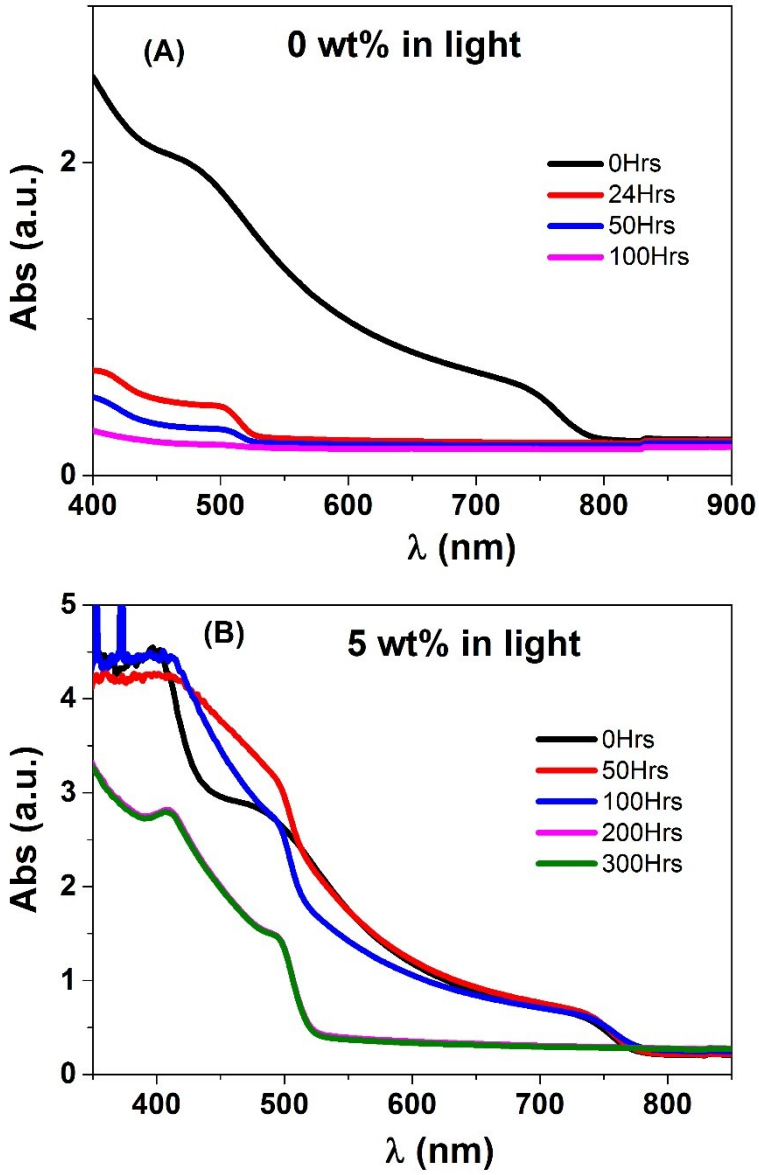

Figure SI 4: Absorbance spectra of 0 and 5 wt.% PEP films in light (a & b).

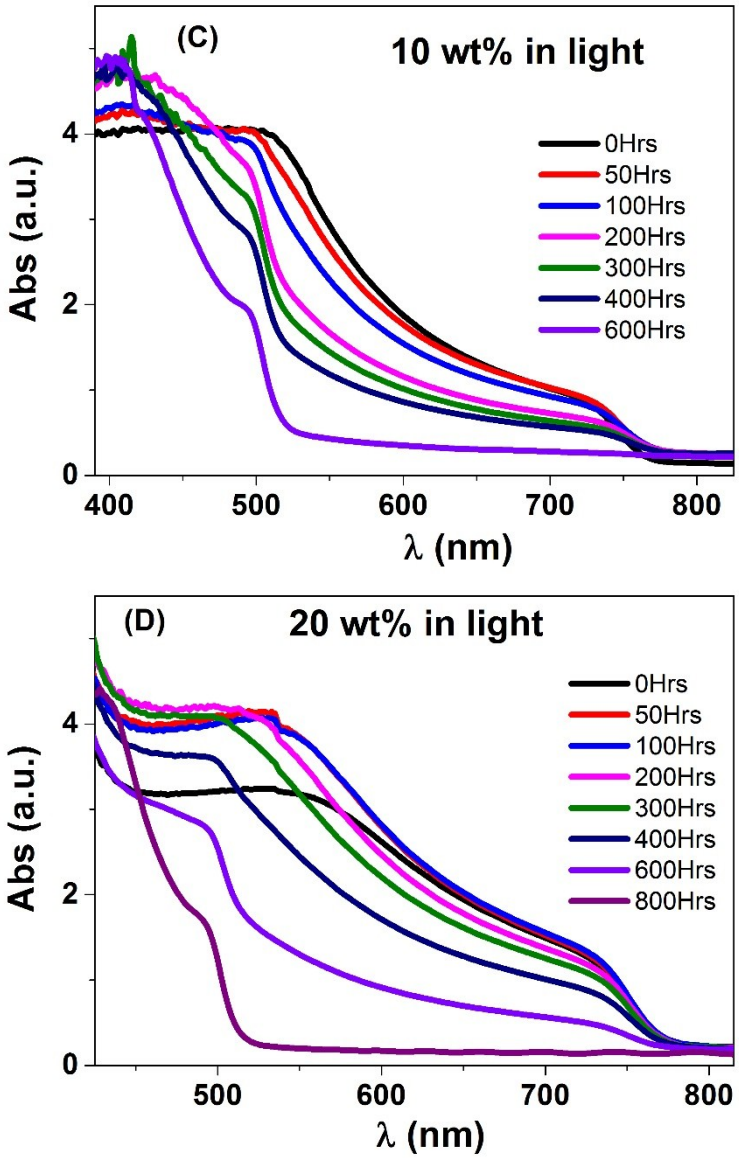

Figure SI 4: Absorbance spectra of 10 and 20 wt.% PEP films in light (c & d).

PL in dark

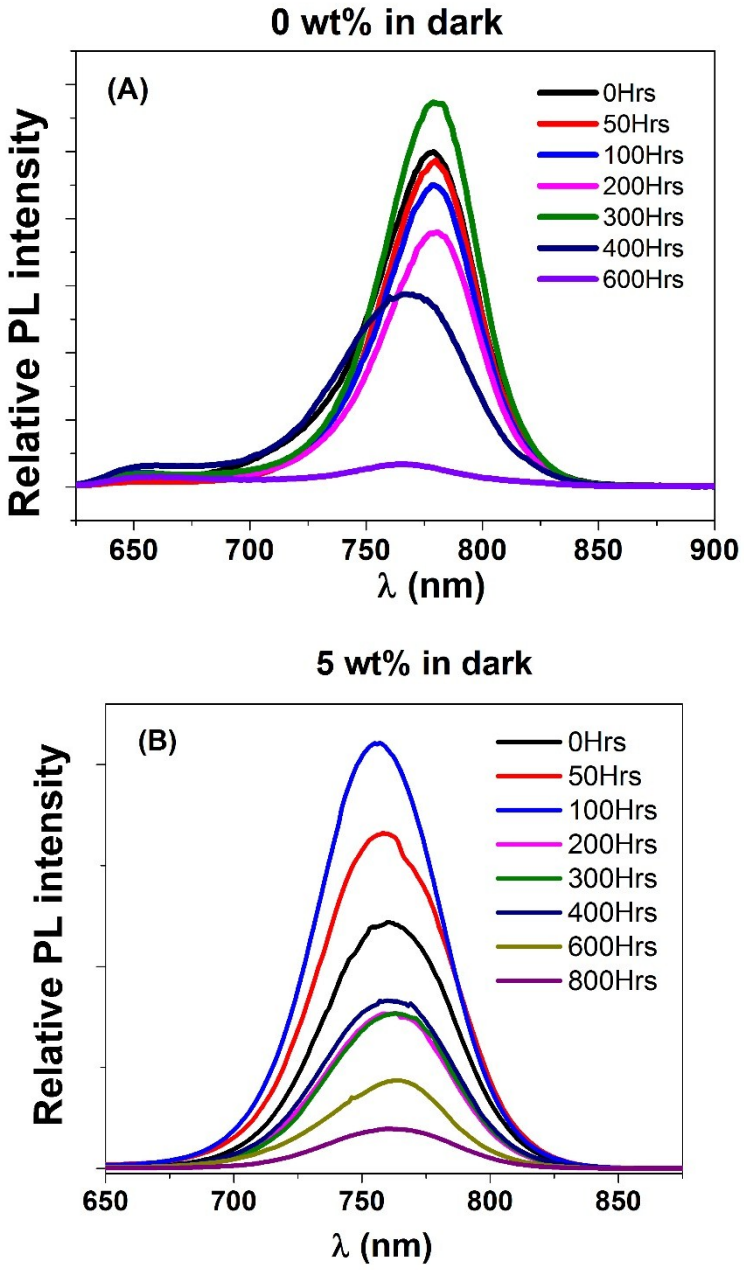

Figure SI 5: PL spectra of 0 and 5 wt.% PEP films in dark (a & b).

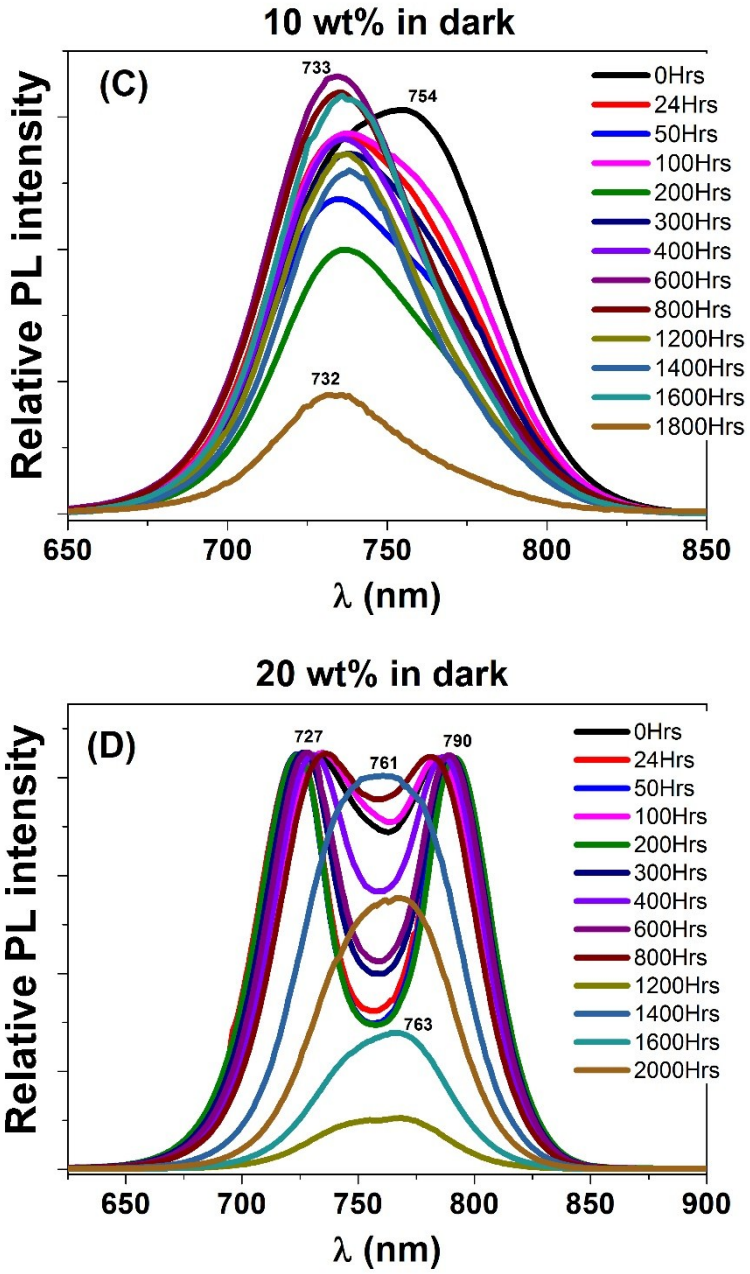

Figure SI 5: PL spectra of 10 and 20 wt.% PEP films in dark (c & d).

PL in light

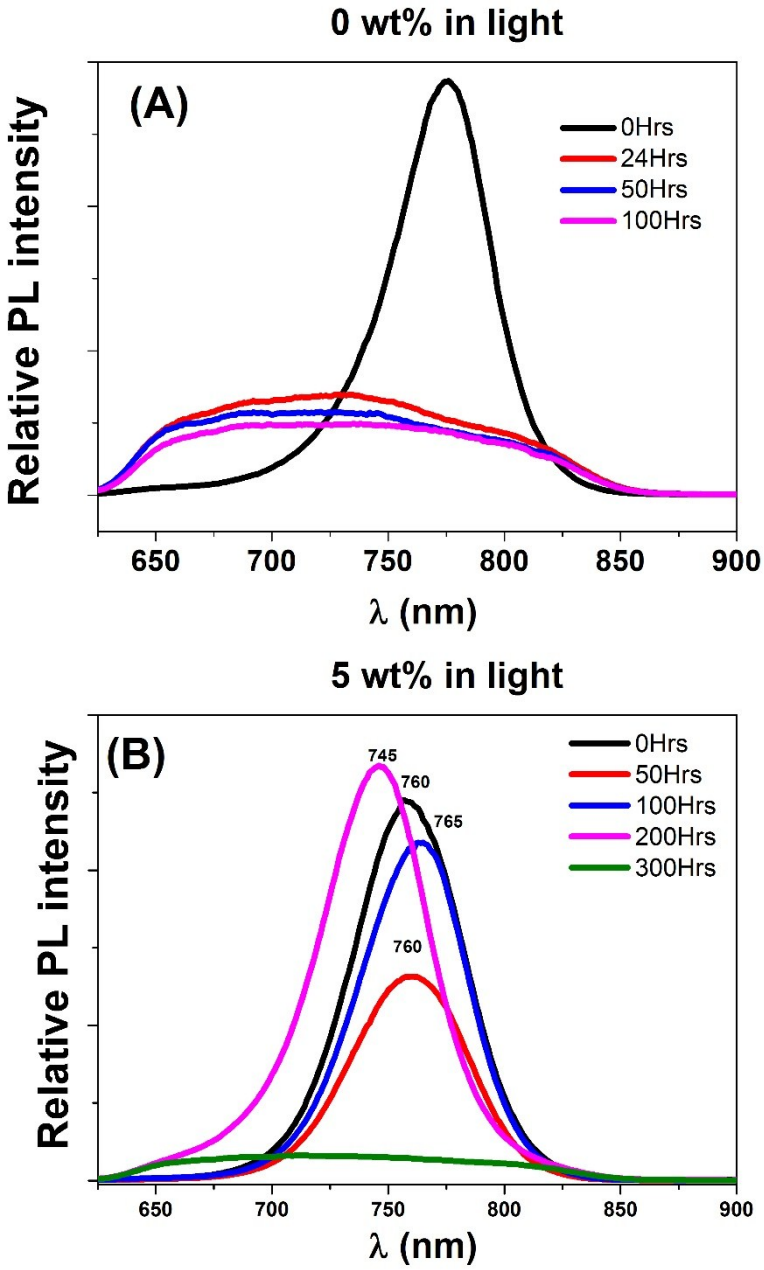

Figure SI 6: PL spectra of 0 and 5 wt.% PEP films in light (a & b).

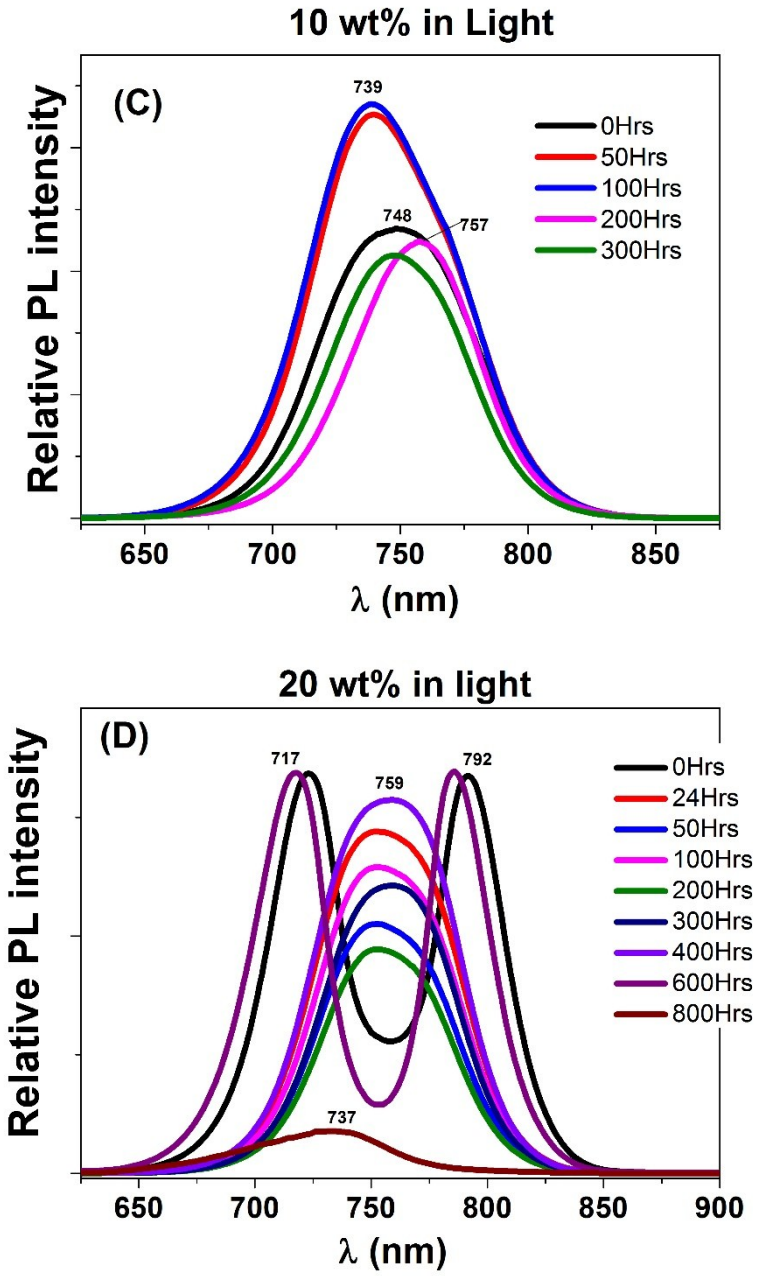

Figure SI 6: PL spectra of 10 and 20 wt.% PEP films in light (c & d).

FTIR of Fresh perovskite films

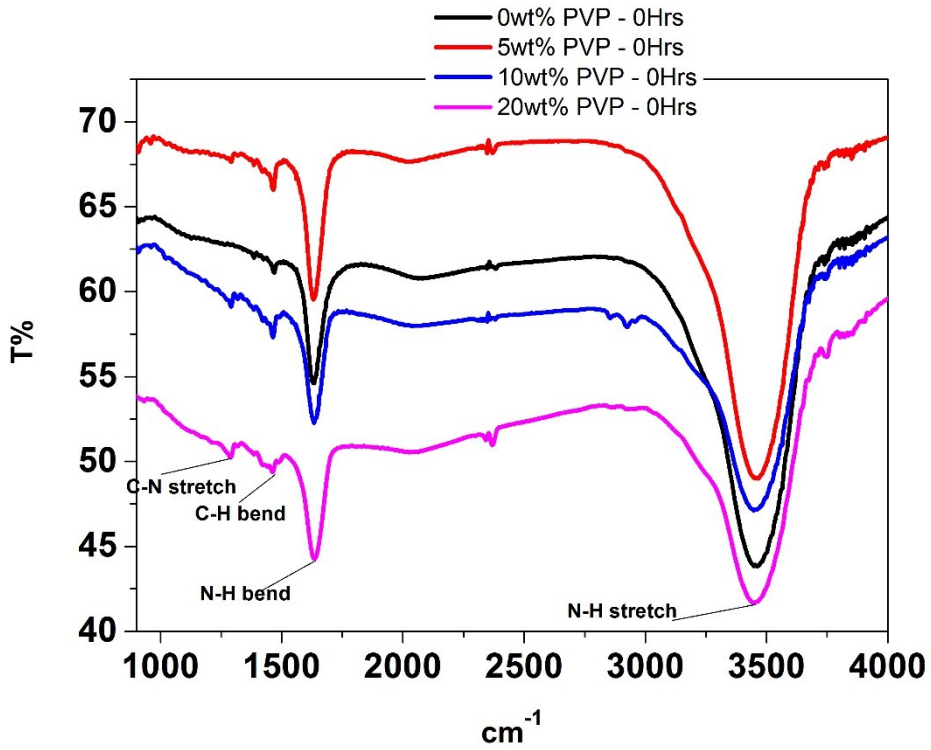

Figure SI 7: FTIR spectra of pure and PVP incorporated perovskite films.

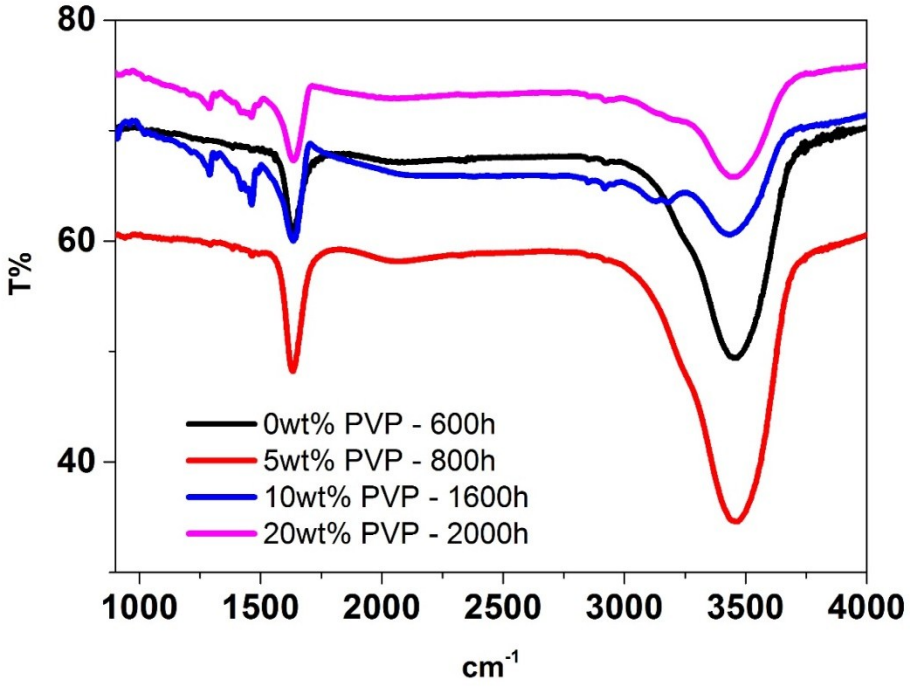

Figure SI 8: FTIR spectra of pure and PVP incorporated perovskite films degraded in dark.

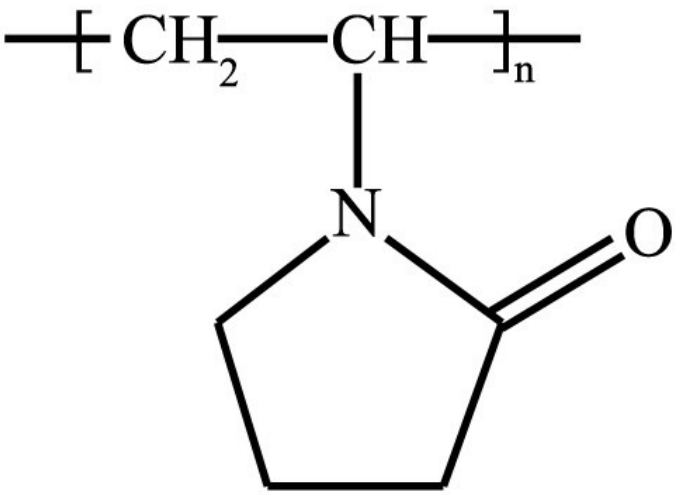

Figure SI 9: Chemical structure of poly-(vinylpyrrolidone) (PVP)

Fabrication of perovskite solar cells

PSCs were fabricated in a glove box via single step deposition of $CH_3NH_3PbI_{3-X}Cl_X$ over a ~70 nm compact TiO_2 layer (3000 rpm for 40 sec) formed using DC sputtering and annealed at 450 ^oC. Spiro-OMETAD is deposited on top on of perovskite using a method reported elsewhere.[1,2] A 100 nm thick Au back contact is deposited via thermal evaporation.

References

(1) Fakharuddin, A.; Di Giacomo, F.; Palma, A. L.; Matteocci, F.; Ahmed, I.; Razza, S.; D'Epifanio, A.; Licoccia, S.; Ismail, J.; Di Carlo, A.et al. Vertical TiO2 Nanorods as a Medium for Stable and High-Efficiency Perovskite Solar Modules. *ACS Nano* **2015,** *9* (8), 8420.

(2) Fakharuddin, A.; Di Giacomo, F.; Ahmed, I.; Wali, Q.; Brown, T. M.; Jose, R. Role of morphology and crystallinity of nanorod and planar electron transport layers on the performance and long term durability of perovskite solar cells. *Journal of Power Sources* **2015,** *283*, 61.