Supplementary Information

Temperature dependence of hole conductor free formamidinium lead iodide perovskite based solar cells

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The FormAmidinium Iodide (FAI) was prepared by reacting FormAmidine Acetate (FAAc) with hydridic acid (HI) (more details can be found in the experimental section). Figure S1A shows the Nuclear Magnetic Resonance (NMR) spectra of the synthesized FAI and FAAc, for the whole measured range while figure S1B shows a magnification of the scale between 7.77-7.88ppm. The molecular structures of FAAc and FAI are shown in figure 1B.

![Figure S1](image)

Figure S1: (A) NMR measurements of FormAmidine Acetate - FAAc (black) and FormAmidinium Iodide - FAI (red). (B) magnification of the ppm scale in the range of 7.78-7.88ppm, and the chemical structure of FAAc (black) and FAI (red). The green numbers (1-8) identify the different hydrogens in each of the two molecules.

It can be seen that the peak of FAAc (black line) at ~1.95ppm (figure S1A), representing H₃, doesn’t appear in the FAI measurement (red line), as expected. The peak at ~4.80ppm, which corresponds to H₂O traces (D₂O is used as a solvent), is present in both samples, in the exact same chemical shift. The chemical shift of H⁵ is located ~0.04ppm lower than that of H⁸. The reason for this difference is that H⁸ has a more electronegative close neighbor (i.e. I⁻) than H⁵ (i.e. OH). The iodide anion shields the magnetic field of the hydrogens more strongly than the OH group does, thus “pushes” the peak of H⁸ towards higher ppm values. The peaks of H³⁴ and H⁶⁷ do not appear, probably due to...
their deprotonation by the D$_2$O molecule (the replacement of H$_{3,4}$ and H$_{6,7}$ by deuterium). The NMR spectra provide confirmation for the high quality synthesized FAI.

**Figure S2:** Tauc Plot of the different perovskite layers. Inset: Demonstration of $E_g$ extraction for the FAPbI$_3$ sample.

**Figure S3:** Absorption spectra of the studied samples.