# Supporting Information

## Highly stable, phase pure $Cs_2AgBiBr_6$ double perovskite thin films for optoelectronic applications

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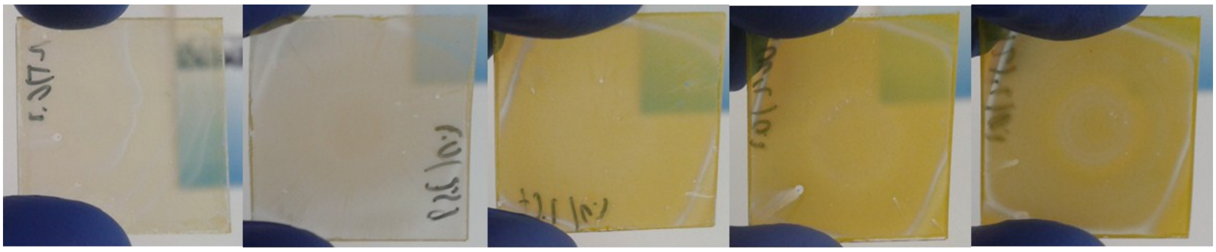
**Table S1.** Solubility of $Cs_2AgBiBr_6$ in different solvents

| Solvent | Max. concentration<br>Mol / L |
|---|---|
| Hydrobromic acid (HBr) | ~ 0.05 |
| *N*,*N*-Dimethylformamide (DMF) | ~ 0.1 |
| Dimethylsulfoxide (DMSO) | ~ 0.6 |
| *N*-Methyl-2-pyrrolidone (NMP) | ~ 0.1 |



**25 °C** **65 °C** **75 °C** **100 °C** **125 °C**

**Figure S1.** Images of $Cs_2AgBiBr_6$ films made on glass prepared with different preheating temperatures. The **25 °C** sample was made at room temperature without a preheating step. The increase of the film quality in terms of surface coverage with increasing preheating temperature is clearly visible, in particular for preheating temperatures of 75 °C and higher.

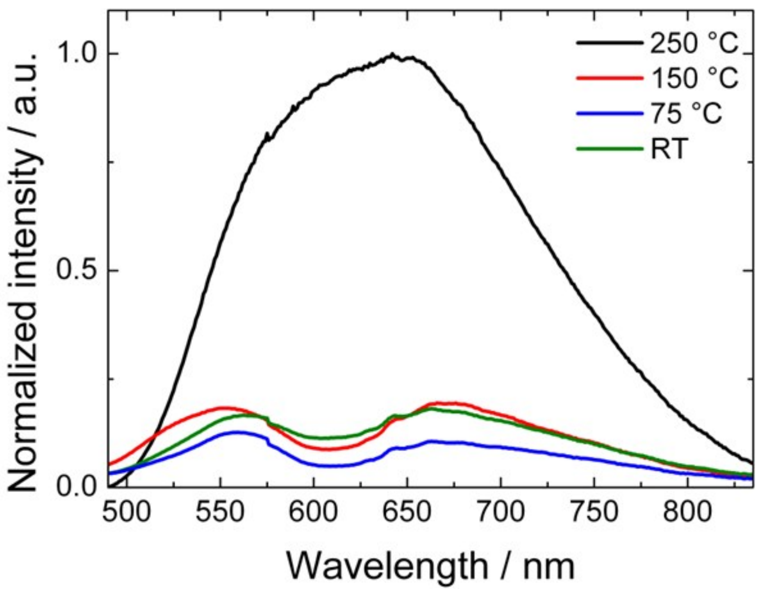



**Figure S2.** The influence of the annealing temperature on the PL signal. The typical PL signal of $Cs_2AgBiBr_6$ is only visible for the 250 °C sample.

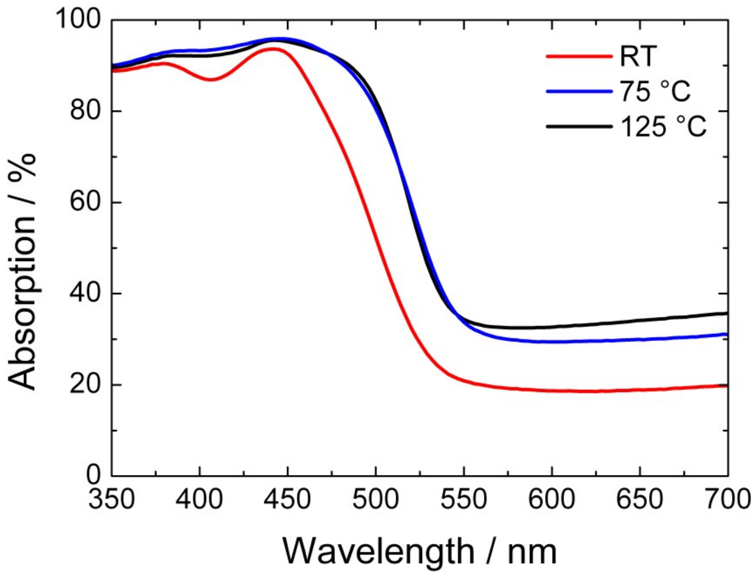



**Figure S3.** UV/vis spectra of $Cs_2AgBiBr_6$ films on mp-$TiO_2$ scaffolds as used for solar cell assembly prepared without (RT, ca. 25 °C) or with a preheating step (75°C, 125 °C). The improved light absorption close to the onset for the preheated samples is clearly visible. We assign the enhanced light absorption at energies below the onset to light scattering because of the roughness of the preheated samples.

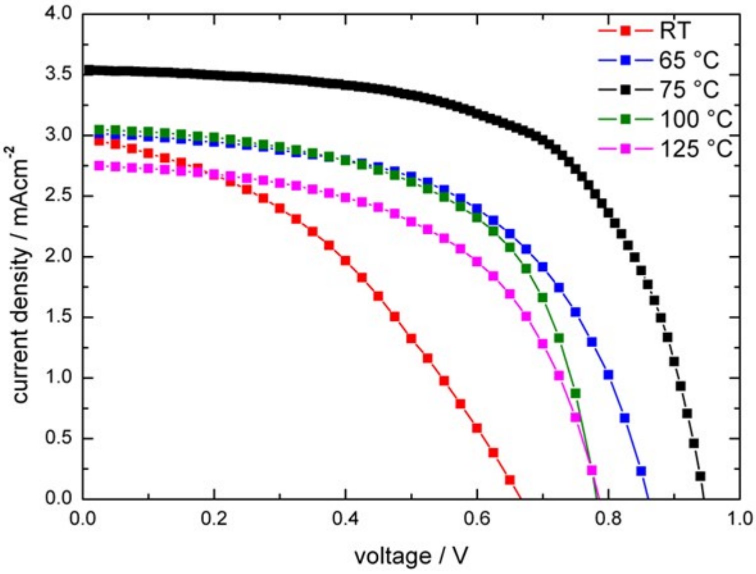



**Figure S4.** *J-V* charcteristics of $Cs_2AgBiBr_6$ based devices prepared with a preheating step at different temperatures. The depicted *J-V* curves show only the backwards scan. The characteristic values of the *J-V* curves are given in Table S2.

**Table S2**. $J_{sc}$, $V_{oc}$, FF and PCE of the *J-V* curves shown in Figure S3.

| Preheating step | $J_{sc}$ / mA/cm² | $V_{oc}$ / V | FF | PCE / % |
|---|---|---|---|---|
| RT | 2.99 | 0.67 | 0.39 | 0.81 |
| 65 °C | 3.02 | 0.86 | 0.55 | 1.45 |
| 75 °C | 3.54 | 0.95 | 0.62 | 2.15 |
| 100 °C | 3.05 | 0.78 | 0.58 | 1.41 |
| 125 °C | 2.75 | 0.78 | 0.54 | 1.20 |

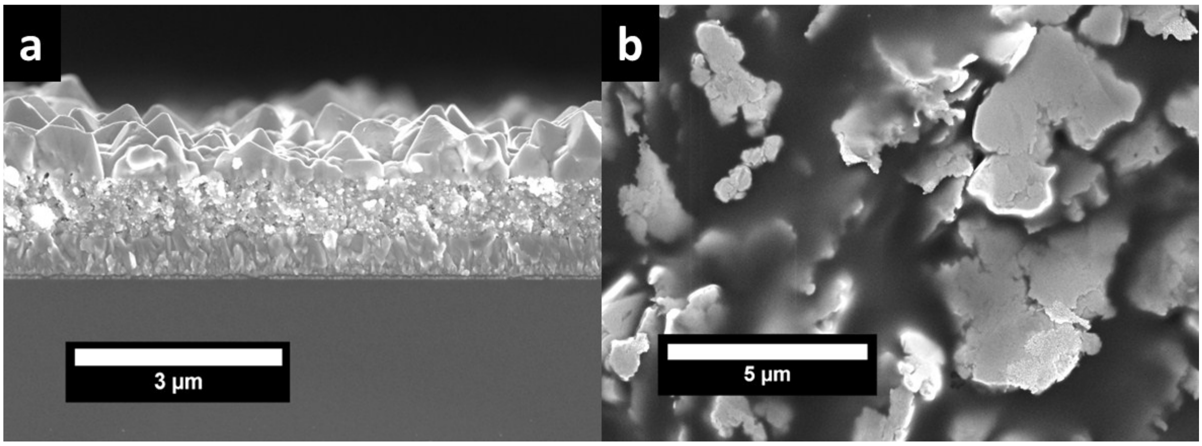



**Figure S5.** (a) SEM cross-section and (b) top-view image of a $Cs_2AgBiBr_6$ film deposited with a preheating step at 125 °C. The presence of a top layer consisting of large crystallites is clearly observable.

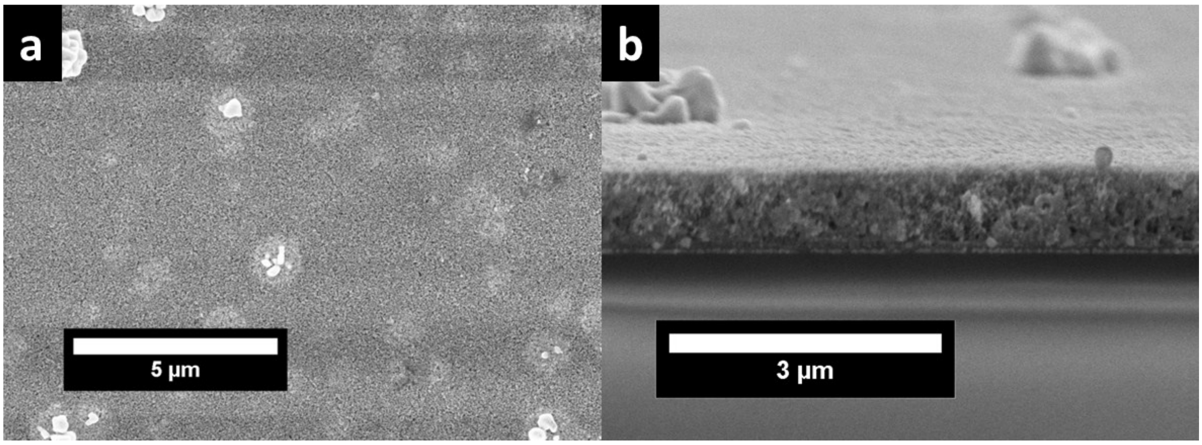



**Figure S6.** (a) SEM cross-section and (b) top-view image of a $Cs_2AgBiBr_6$ film deposited without a preheating step at There are only a few agglomerates visible on top the mp-$TiO_2$ scaffold.

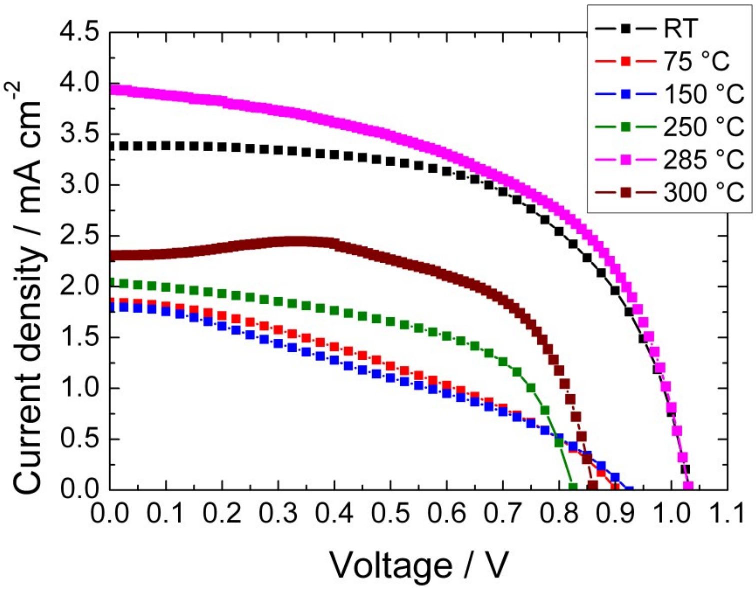



**Figure S7.** *J*-*V* charcteristics of $Cs_2AgBiBr_6$ based solar cells prepared with a 75 °C preheating step and annealed at different temperatures. The depicted *J*-*V* curves show only the backwards scan. The characteristic values of the *J*-*V* curves are given in Table S3. The *J*-*V* curves show a clear decrease of device performance upon 300 °C annealing. Furthermore, for annealing steps at 250 °C and 285 °C, $V_{oc}$´s of more than one volt could be obtained.

**Table S3.** $J_{sc}$, $V_{oc}$, FF and PCE of the J-V curves shown in Figure S5.

| | $J_{sc}$ / mA/cm² | $V_{oc}$ / V | FF | PCE / % |
|---|---|---|---|---|
| RT | 1.80 | 0.92 | 0.34 | 0.58 |
| 75 °C | 1.85 | 0.90 | 0.37 | 0.63 |
| 150 °C | 2.02 | 0.82 | 0.55 | 0.93 |
| 250°C | 3.38 | 1.03 | 0.59 | 2.15 |
| 285 °C | 3.94 | 1.03 | 0.54 | 2.20 |
| 300 °C | 2.30 | 0.86 | 0.66 | 1.25 |

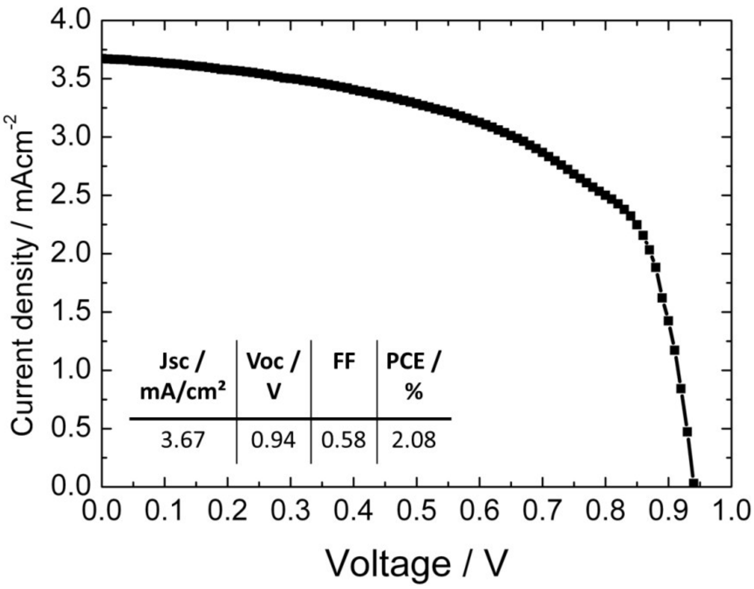



**Figure S8.** *J-V* curve of the solar cell used for the EQE measurements.

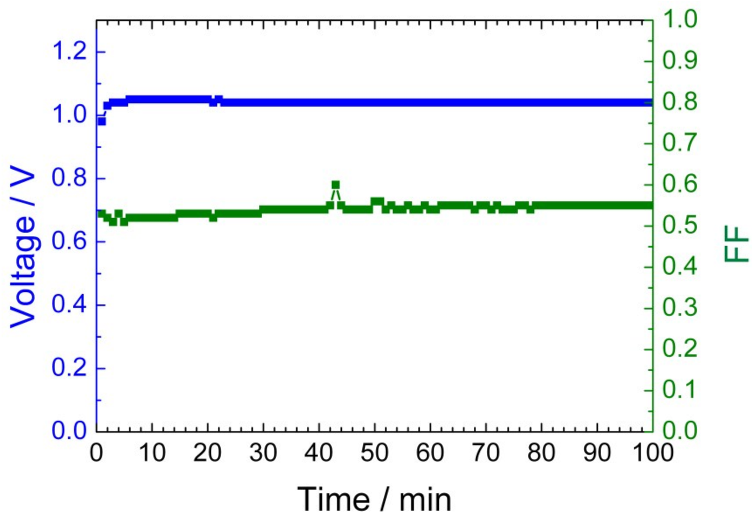



**Figure S9.** $V_{oc}$ and FF of the device given in Figure 6.

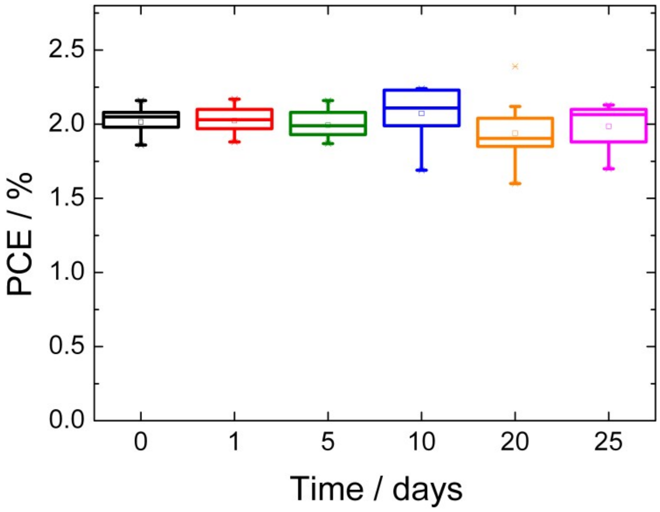



**Figure S10.** Development of the PCEs of 12 devices, prepared according the procedure described in Figure 1, stored under ambient conditions in the dark for 25 days, revealing excellent device stability. No significant performance loss is observable.