**A holistic study on the effect of annealing temperature and time on CH3NH3PbI3-based perovskite solar cell characteristics**

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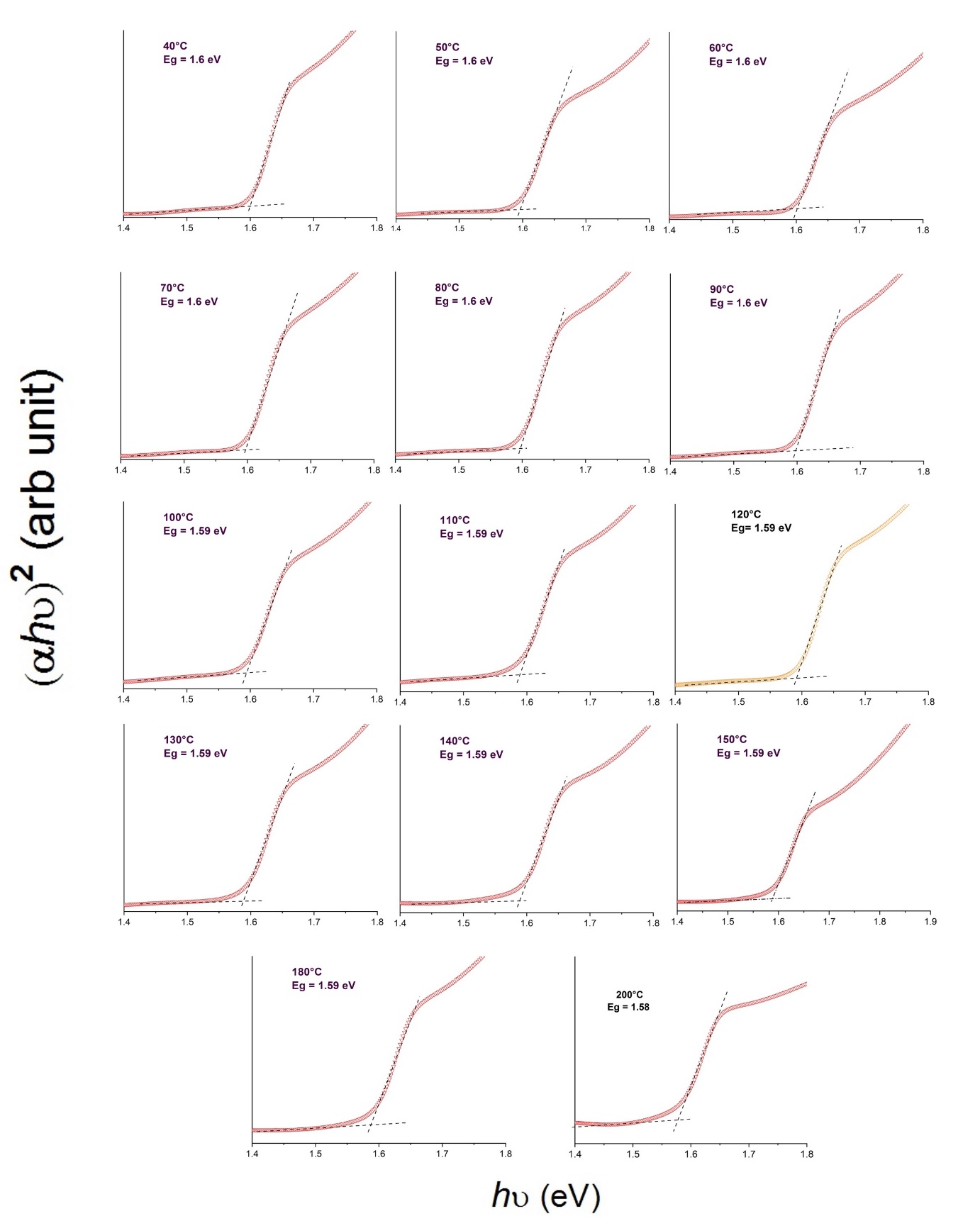
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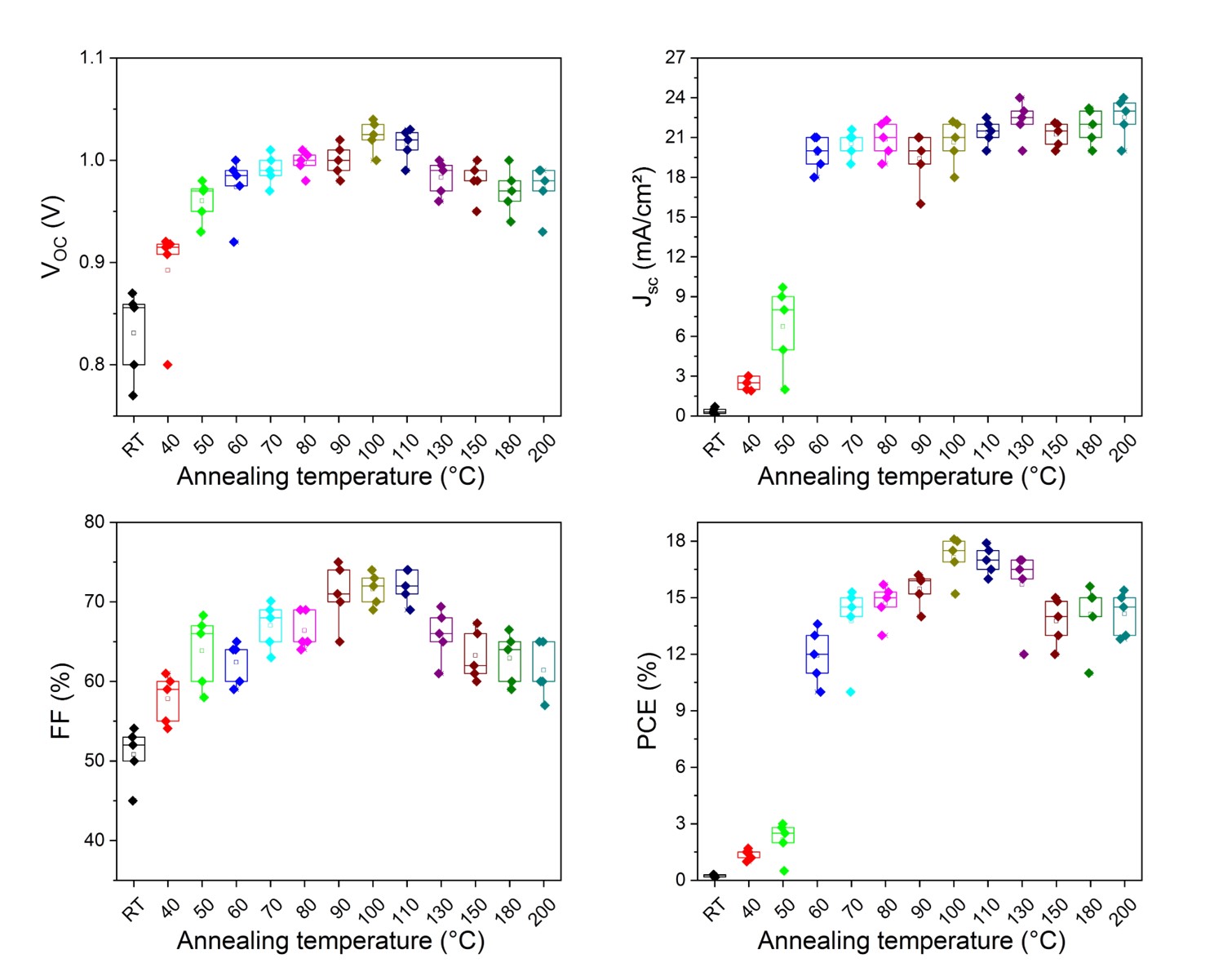
**Supplementary information**



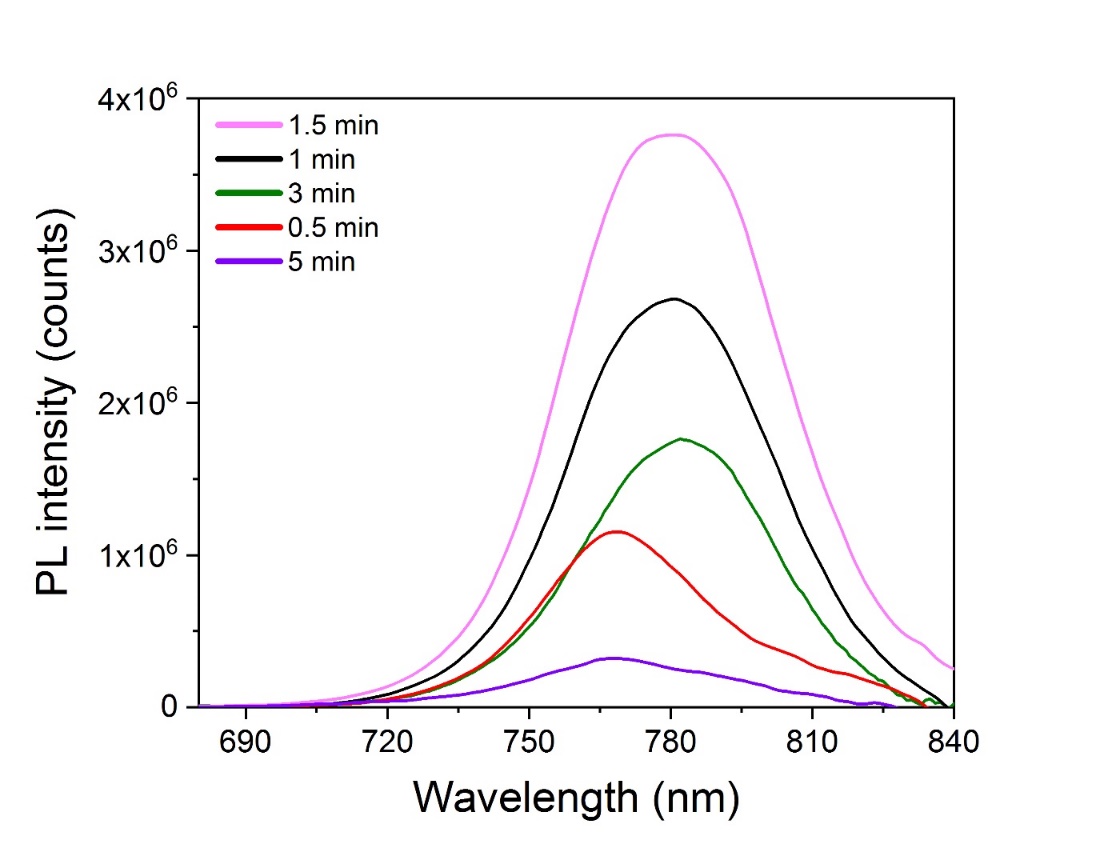
**Figure S1.** Evolution of the UV−visible absorption spectrum as a function of annealing temperature.



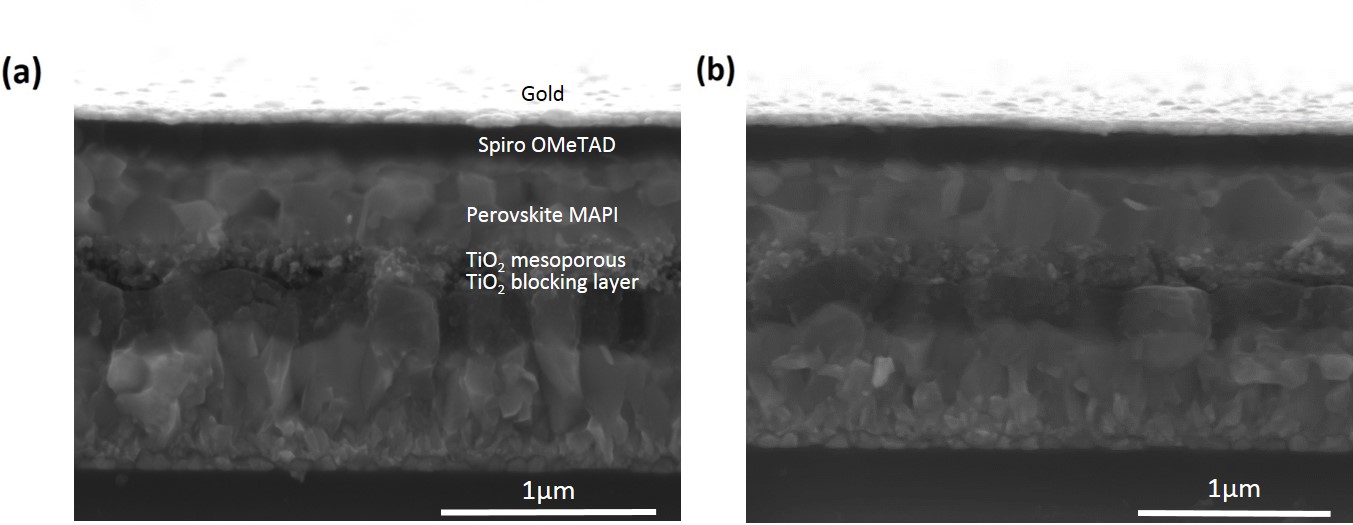
**Figure S2.** Tauc plot comparison for different MAPbI3 film annealed at different temperatures



**Figure S3** . Statistics parameters of *Jsc*, *Voc*, *FF*, and PCE for the PSCs prepared with different annealing temperatures.



**Figure S4** . Comparison of steady-state PL measured at 450 nm excitation for MAPbI3 film annealed at 200°C as a function of time



**Figure S5**. High magnification cross-sectional SEM images of (a) MAPbI3 film annealed at 100°C during 30 minutes (b) MAPbI3 film annealed at 200°C for 1.5 minutes.

**Table S1**. Summary of opto-electronic parameters obtained for the films annealed between the room-temperature and 200 °C.

|  |  |  |  |  |
| --- | --- | --- | --- | --- |
| Annealing Temperature | Bandgap  (eV) | PL band  (nm) | FWHM of PL (nm) | Urbach energy (meV) |
| RT | - | 735 | 85 | - |
| 40°C | 1.60 | 770 | 61 | 59.5 |
| 50°C | 1.60 | 774 | 57 | 64.5 |
| 60°C | 1.60 | 773 | 57 | 56.5 |
| 70°C | 1.60 | 772 | 52 | 64.0 |
| 80°C | 1.60 | 771 | 57 | 62.0 |
| 90°C | 1.60 | 780 | 55 | 61.8 |
| 100°C | 1.59 | 780 | 47 | 81.0 |
| 110°C | 1.59 | 781 | 46 | 83.0 |
| 120°C | 1.59 | 770 | 47 | 84.0 |
| 130°C | 1.59 | 770 | 47 | 87.5 |
| 140°C | 1.59 | 775 | 47 | 86.2 |
| 150°C | 1.59 | 780 | 50 | 90.5 |
| 180°C | 1.59 | - | - | 96.2 |
| 200°C | 1.58 | 780 | 49 | 103.5 |

**Table S2.** Summary of device performances obtained in reverse scan under AM 1.5G conditions for different annealing temperatures of MAPbI3 film between room-temperature and 200°C.

|  |  |  |  |  |
| --- | --- | --- | --- | --- |
| T (°C) | Voc (V) | Jsc (mA/cm2) | FF (%) | PCE (%) |
| RT | 0.87 | 0.7 | 54.6 | 0.3 |
| 40 | 0.92 | 3.0 | 61.0 | 1.7 |
| 50 | 0.98 | 9.7 | 68.3 | 3.0 |
| 60 | 1.00 | 21.0 | 65.0 | 13.6 |
| 70 | 1.01 | 21.6 | 70.1 | 15.3 |
| 80 | 1.01 | 22.3 | 69.0 | 15.7 |
| 90 | 1.02 | 21.0 | 75.0 | 16.2 |
| 100 | 1.04 | 22.2 | 74.3 | 18.1 |
| 110 | 1.03 | 22.5 | 74 | 17.9 |
| 130 | 1.00 | 24.0 | 69.4 | 17.0 |
| 150 | 1.00 | 22.1 | 67.3 | 15.0 |
| 180 | 1.00 | 23.2 | 66.5 | 15.6 |
| 200 | 0.99 | 24.0 | 65.0 | 15.4 |