Supporting Documents

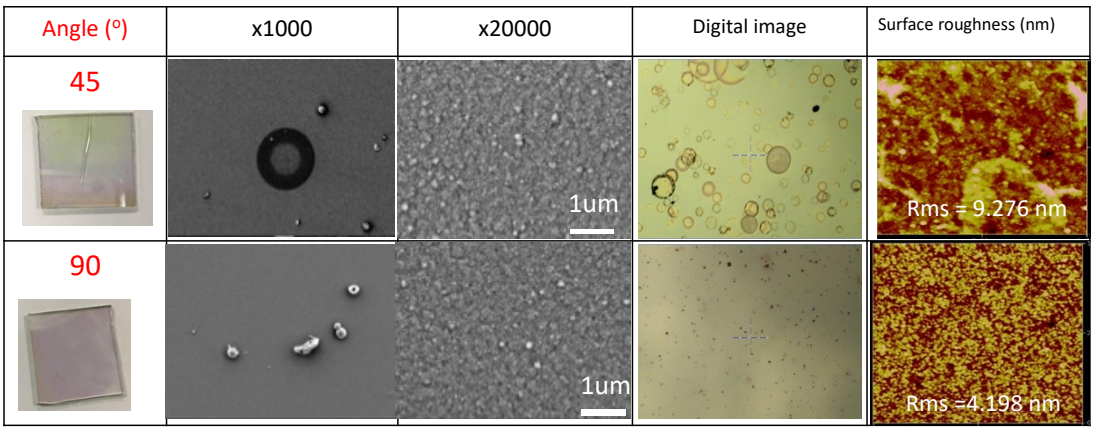

Figure S1 SEM images, optical image and AFM images of TiO_2 layer from spraying angle at 45^O and 90^O.

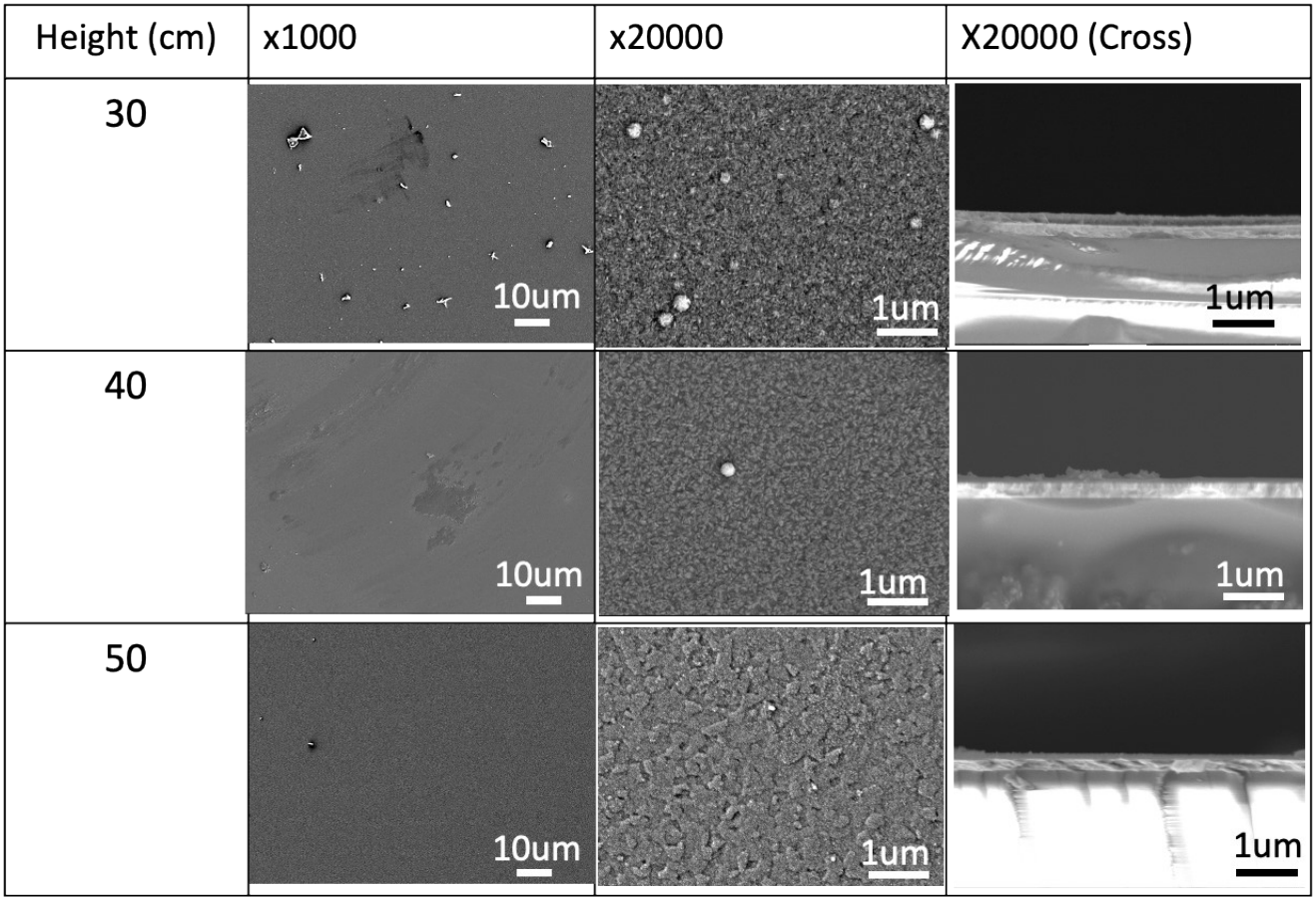

Figure S2 SEM images at low and high resolution of c-TiO_2 layer from different spray height at 30, 40 and 50 cm.

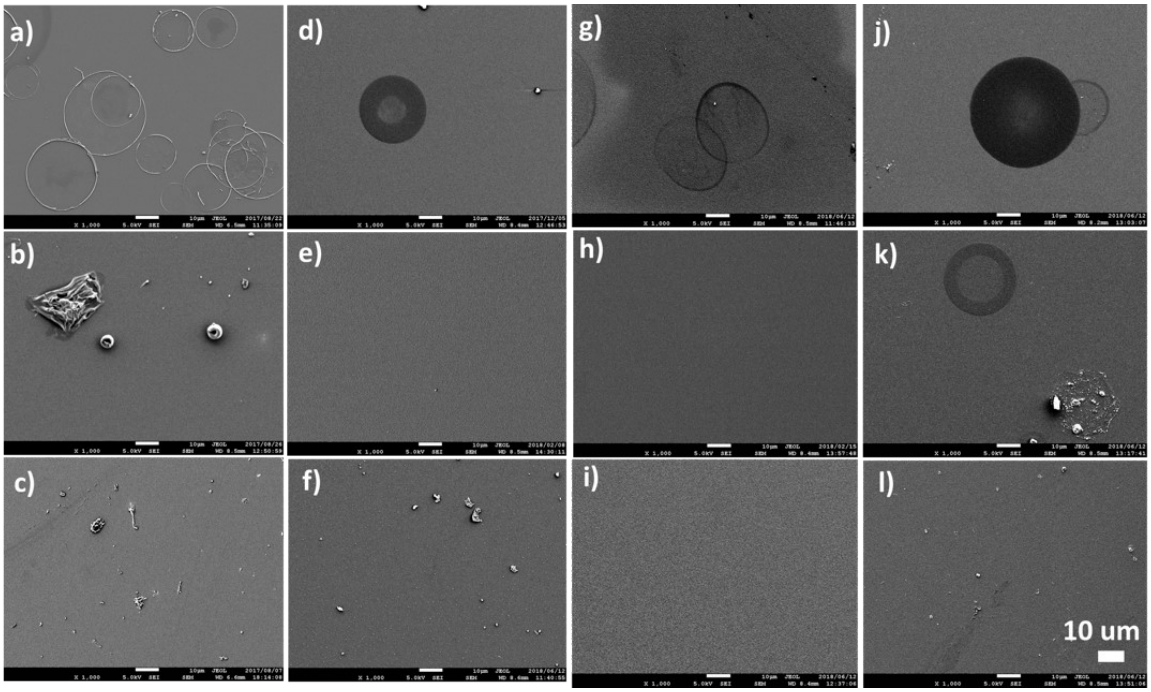

Figure S3 SEM images of TiO_2 layer from different alcoholic solvents and spray temperature T_s. (a-c) TiO_2 from EtOH (boiling point T_b = 78.2°C) as precursor solvent T_s = 350, 450 and 550°C, respectively. (d-f) TiO_2 from IPA (T_b = 82.3°C) as precursor solvent T_s = 350, 450 and 550°C, respectively. (g-i) TiO_2 from 1-butanol (T_b = 117.2°C) as precursor solvent T_s = 350, 450 and 550°C, respectively. (j-l) TiO_2 from 2-butanol (T_b = 99.5°C) as precursor solvent T_s = 350, 450 and 550°C, respectively. All sample was annealed at T_a = 400°C

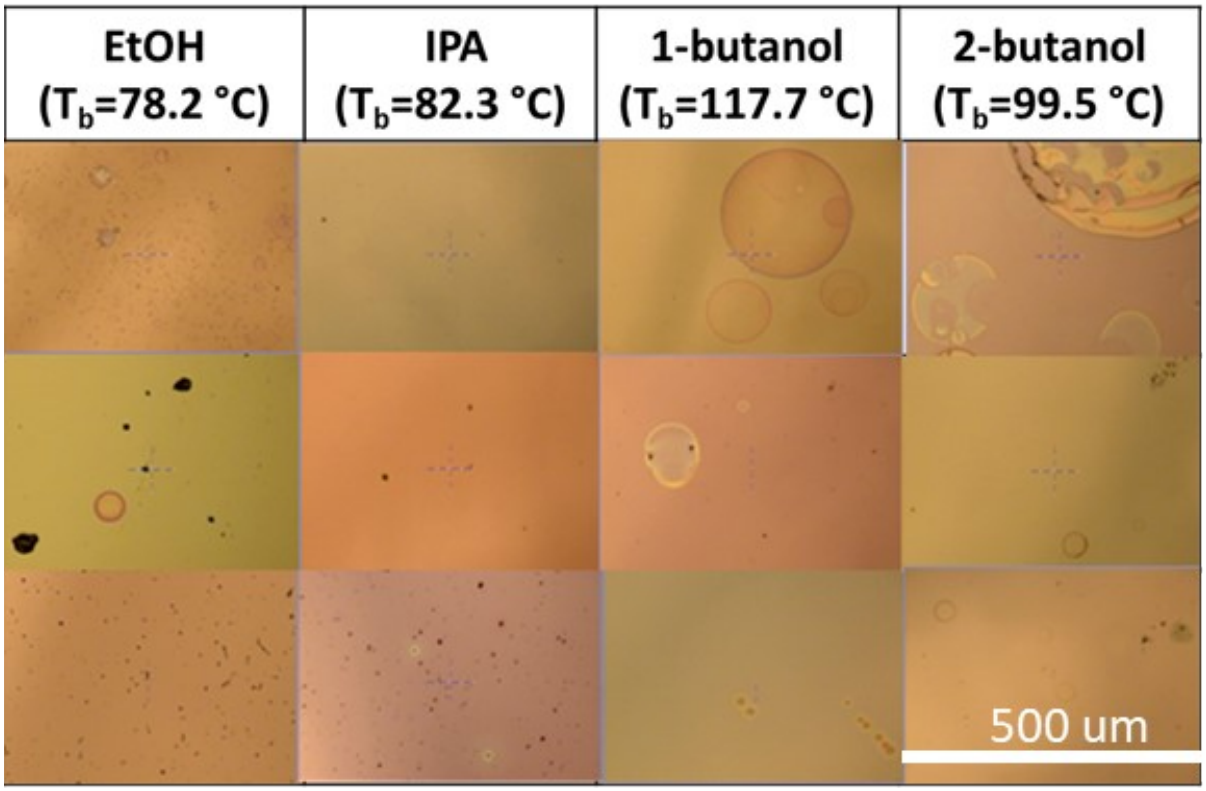

Figure S4 Microscopic images of TiO_2 layer from different alcoholic solvents and T_s. (a-c) TiO_2 from EtOH (T_b = 78.2°C) as precursor solvent T_s = 350, 450 and 550°C, respectively. (d-f) TiO_2 from IPA (T_b = 82.3°C) as precursor solvent T_s = 350, 450 and 550°C, respectively. (g-i) TiO_2 from 1-butanol (T_b = 117.2°C) as precursor solvent T_s = 350, 450 and 550°C, respectively. (j-l) TiO_2 from 2-butanol (T_b = 99.5°C) as precursor solvent T_s = 350, 450 and 550°C, respectively. All sample was annealed at Ta = 400°C.

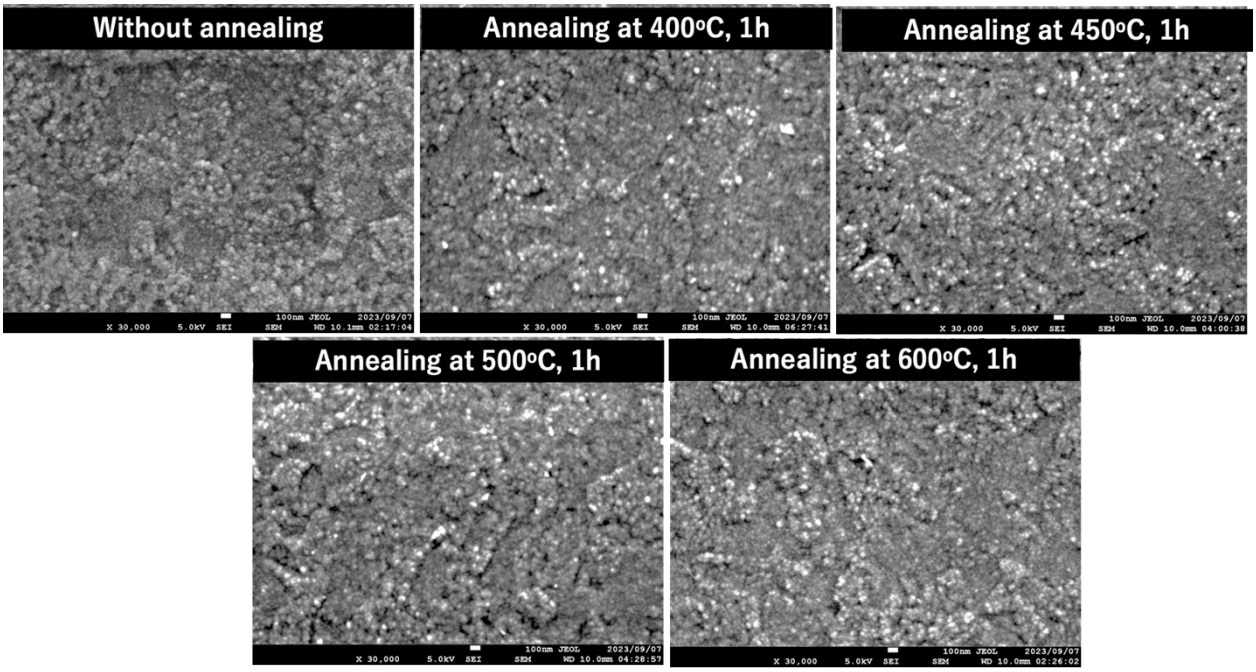

Figure S5 Surface SEM images of ITO substrates under different annealing temperatures (Ta=25, 400, 450, 500, and 600°C).

3.4 Wettability of c-TiO_2

After depositing c-TiO_2 via spray pyrolysis, the wettability of the film by water is used to determine its uniformity and cleanliness. SEM images of $MAPbI_3$ perovskite film as deposited on a c-TiO_2 layer and after leaving the TiO_2 surface in ambient atmosphere for 45 minutes and >120 minutes, respectively, are shown in Figures S6a and S6b. The SEM images of the samples clearly demonstrate that exposing the TiO_2 layer for 45 minutes after deposition results in a pin-hole-free $MAPbI_3$ layer on TiO_2. The contact angles of water droplets on c-TiO_2 films and the duration of exposure to ambient air after deposition of the c-TiO_2 layer are shown in Figures 5c and 5d. The obtained perovskite layer has a homogeneous surface coverage. When the duration exceeded 120 minutes, the perovskite film exhibited decreased wettability and developed pinholes on its surface, as shown in Figure S6c. The high angle droplets could be the result of dust or organic species impurities deposited on the film surface by the ambient atmosphere.

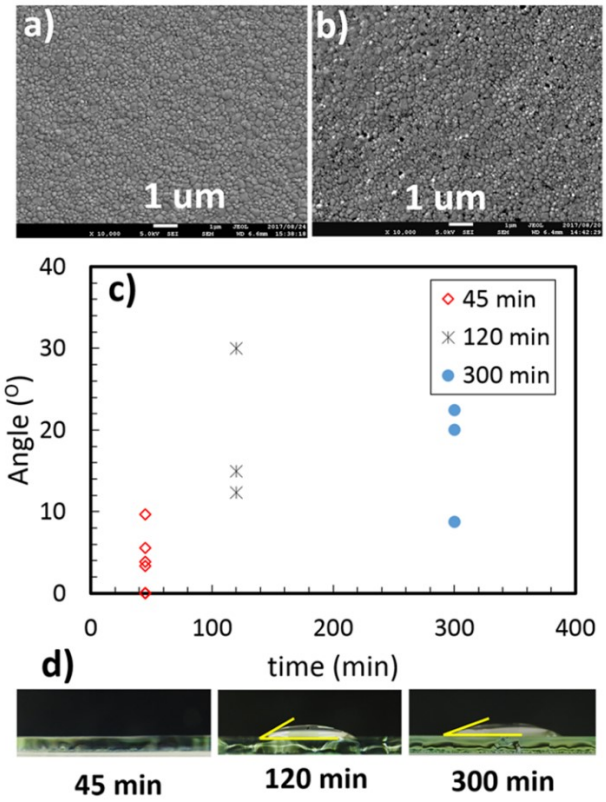

Figure S6. (a) SEM image of the perovskite layer when duration of exposure to the ambient air = 45 min and (b) SEM image of the perovskite layer when the duration was > 120 min. (c) relationship between the duration of c-TiO_2 exposure to ambient air and the angle of the droplet (d) droplet shape when duration of exposure to the ambient air was varied from 45, 120, and 300 min.

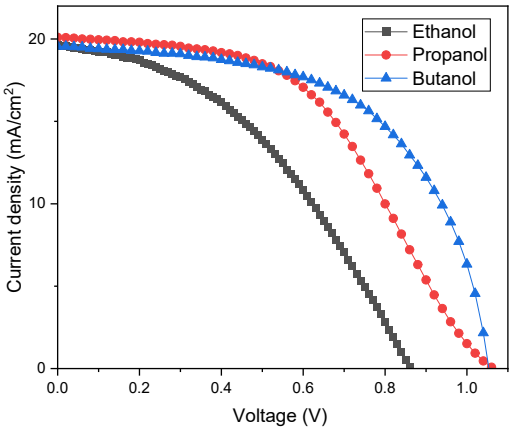

Figure S7 J-V characteristics the best perovskite solar cell when using different solvents.

Table S1. Performance characterizations of PSCs from various solvent.

Sample	V_{oc} (V)	J_{sc} (mA/cm^2)	FF	PCE (%)	Rsh (Ohm.cm^2)	Rs, (Ohm.cm^2)
EtOH	0.86	19.64	0.41	6.96	342.86	21.43
2-Propanol	1.07	20.12	0.48	10.34	555.56	54.95
1-Butanol	1.05	19.56	0.58	11.89	1666.67	7.18