SUPPLEMENTARY INFORMATION FILE

The comprehensive study of TiO_2 blocking layer with complementary electrochemical and SPM methods for the application in photovoltaics

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I UV-VIS

Table S1. Values of UV-VIS transmittance spectra at 535 nm

Deposition method	Sample name and transmittance [%] at 535 nm			
SPUTTERING	**SP_11**	89.2	**SP_21**	90.8
	SP_12	86.5	**SP_22**	91.2
	SP_13	82.5	**SP_23**	91.2
	SP_14	82.3	**SP_24**	90.3
	SP_15	75.9		
	SP_16	69.6		

SPIN-COATING	**SC_11**	91.5	**SC_21**	86.5	**SC_31**	80.3
	SC_12	91.5	**SC_22**	85.2	**SC_32**	80.3
	SC_13	91.5	**SC_23**	86.0	**SC_33**	83.8

	CB_1	86.6	**CB_4**	89.8

CHEMICAL BATH DEPOSITION	**CB_2**	88.4	**CB_5**	86.4
	CB_3	89.8	**CB_6**	88.2

Table S2. Optical absorption edge of TiO_2 films estimated from transmittance spectra

Deposition method	**Optical absorption edge [nm]**			
SPUTTERING	**SP_11**	/	**SP_21**	302
	SP_12	/	**SP_22**	303
	SP_13	/	**SP_23**	305
	SP_14	/	**SP_24**	306
	SP_15	/		
	SP_16	/		

SPIN-COATING	**SC_11**	318	**SC_21**	328	**SC_31**	/
	SC_12	317	**SC_22**	333	**SC_32**	/
	SC_13	320	**SC_23**	333	**SC_33**	331

CHEMICAL BATH DEPOSITION	**CB_1**	332	**CB_4**	321
	CB_2	325	**CB_5**	332
	CB_3	332	**CB_6**	323

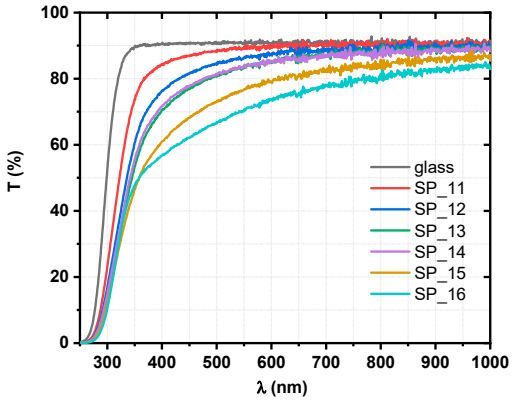
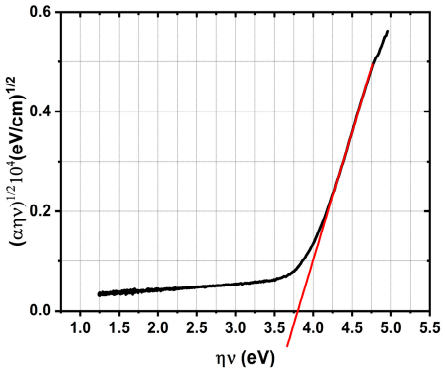
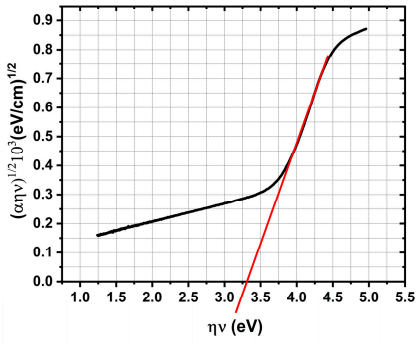


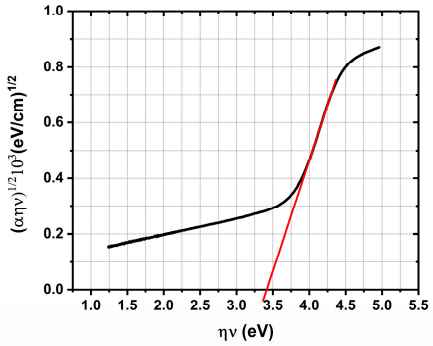
Figure S1. Transmittance spectra of the first sputtered series SP_11-16



(a)



(b)



(c)

Figure S2. Tauc plots of the TiO_2 deposited blocking layers SP_23 (a), SC_33 (b), and CB_2 (c) on the microscopic glass substrates.

II EIS

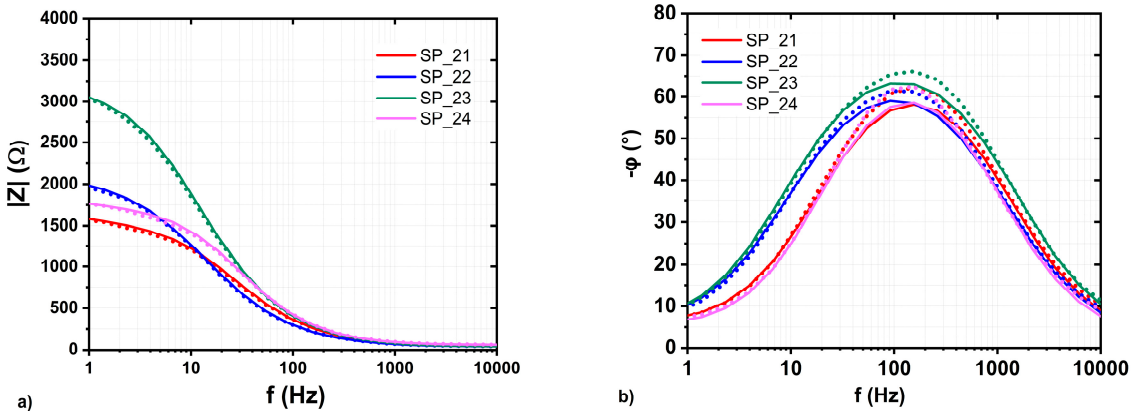


Figure S3. Bode impedance magnitude (a) and phase (b) diagrams of the second series of sputtered samples SP_21-26. Dot lines represent experimental data, while the solid lines represent data obtained by fitting using an equivalent circuit presented in Figure 5b.

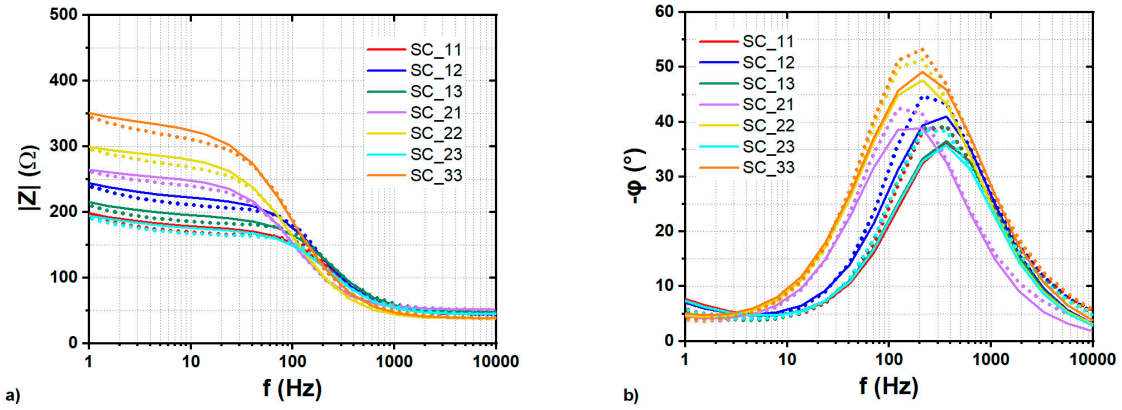


Figure S4. Bode impedance magnitude (a) and phase (b) diagrams of the spin-coated samples SC_11-23 and SC_33. Dot lines represent experimental data, while the solid lines represent data obtained by fitting using an equivalent circuit presented in Figure 5b.

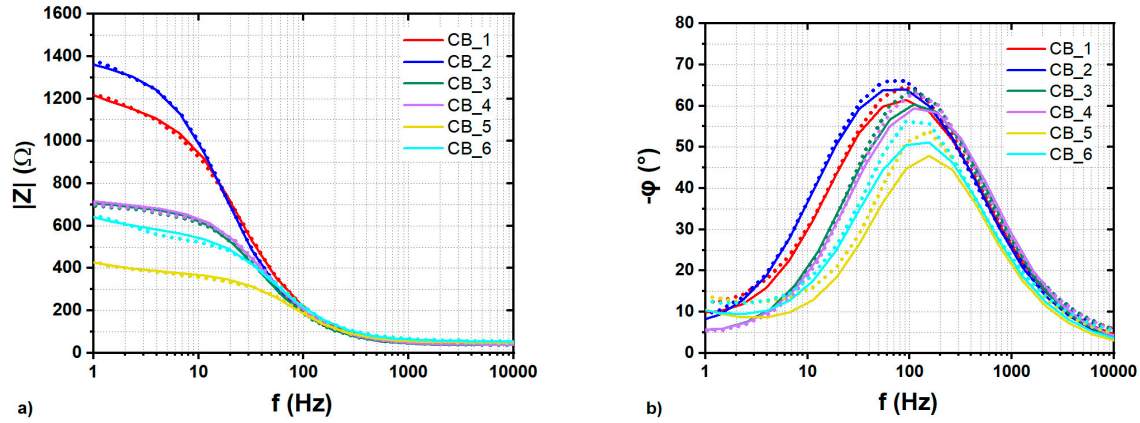


Figure S5. Bode impedance magnitude (a) and phase (b) diagrams of the chemical bath deposited samples CB_1-6. Dot lines represent experimental data, while the solid lines represent data obtained by fitting using an equivalent circuit presented in Figure 5b.

III SEM

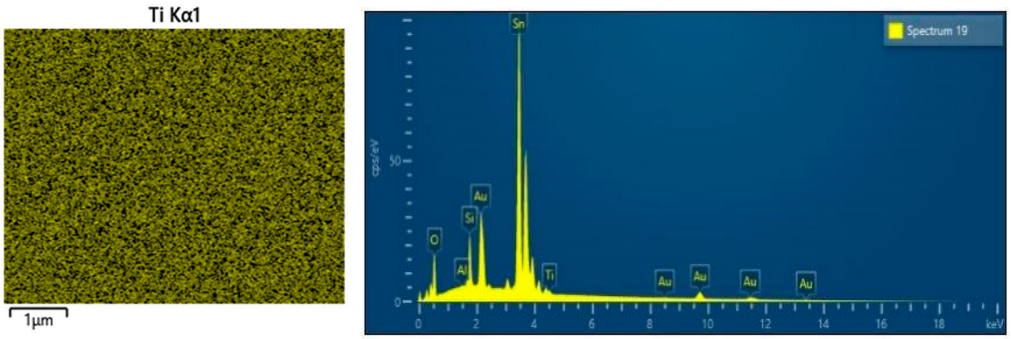


Figure S6. EDS analysis of sample SP_21

Table S3. Elemental percentage analysis of the sample SP_21

Element	Line Type	Weight %	Weight % Sigma	Atomic %	Oxide	Oxide %	Oxide % Sigma
O	K series	23.94	0.04	66.65			

Al	K series	0.07	0.02	0.11	Al_2O_3	0.13	0.04
Si	K series	3.76	0.02	5.97	SiO_2	8.05	0.05
Ti	K series	0.30	0.02	0.28	TiO_2	0.51	0.04
Sn	L series	71.92	0.05	26.99	SnO_2	91.32	0.06
Total		100.00		100.00		100.00	

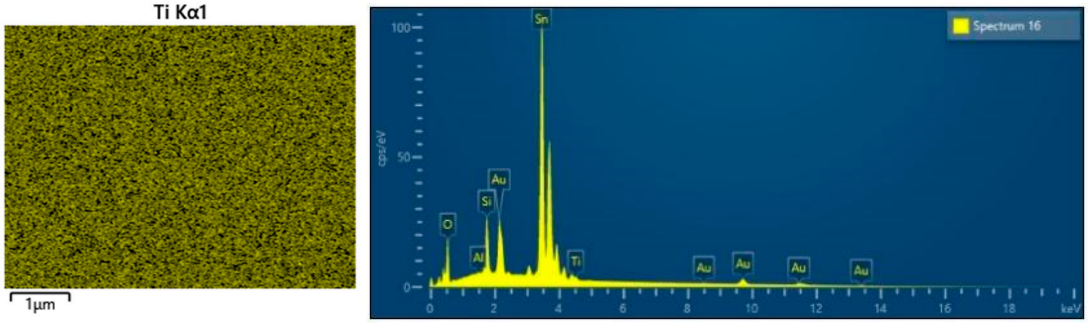


Figure S7. EDS analysis of sample SP_22

Table S4. Elemental percentage analysis of the sample SP_22

Element	Line Type	Weight %	Weight % Sigma	Atomic %	Oxide	Oxide %	Oxide % Sigma
O	K series	24.28	0.04	66.64			
Al	K series	0.09	0.02	0.15	Al_2O_3	0.18	0.03
Si	K series	4.20	0.02	6.57	SiO_2	8.99	0.05
Ti	K series	0.40	0.02	0.36	TiO_2	0.66	0.04
Sn	L series	71.02	0.05	26.27	SnO_2	90.17	0.06
Total		100.00		100.00		100.00	

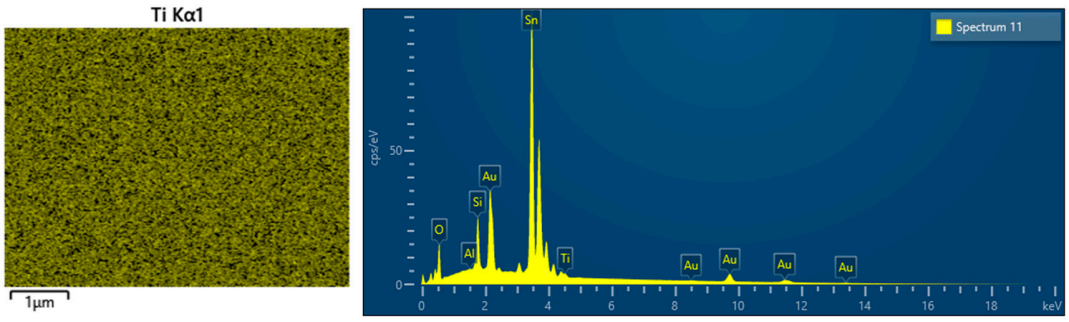


Figure S8. EDS analysis of sample SP_24

Table S5. Elemental percentage analysis of the sample SP_24

Element	Line Type	Weight %	Weight % Sigma	Atomic %	Oxide	Oxide %	Oxide % Sigma
O	K series	24.10	0.04	66.64			
Al	K series	0.08	0.02	0.14	Al2O3	0.16	0.04
Si	K series	3.92	0.02	6.18	SiO2	8.39	0.05
Ti	K series	0.44	0.02	0.41	TiO2	0.74	0.04
Sn	L series	71.45	0.05	26.63	SnO2	90.71	0.06
Total		100.00		100.00		100.00	

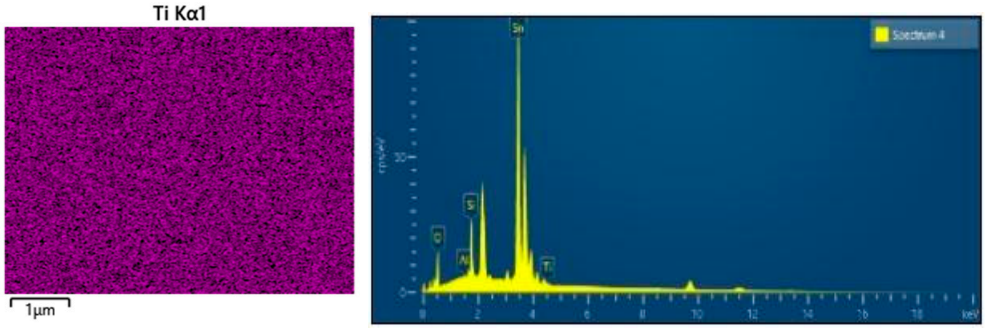


Figure S9. EDS analysis of sample CB_1

Table S6. Elemental percentage analysis of the sample CB_1

Element	Line Type	Weight %	Weight % Sigma	Atomic %	Oxide	Oxide %	Oxide % Sigma
O	K series	24.29	0.04	66.63			
Al	K series	0.13	0.02	0.21	Al_2O_3	0.25	0.04
Si	K series	4.24	0.02	6.62	SiO_2	9.06	0.05
Ti	K series	0.30	0.02	0.28	TiO_2	0.50	0.04
Sn	L series	71.04	0.05	26.26	SnO_2	90.19	0.07
Total		100.00		100.00		100.00	

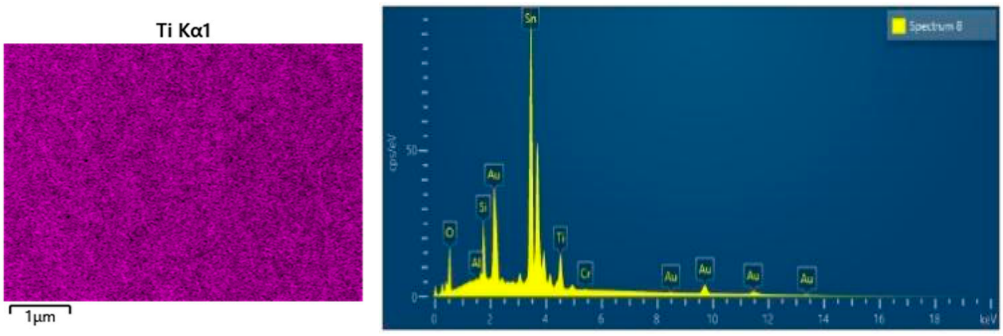


Figure S10. EDS analysis of sample CB_2

Table S7. Elemental percentage analysis of the sample CB_2

Element	Line Type	Weight %	Weight % Sigma	Atomic %	Oxide	Oxide %	Oxide % Sigma
O	K series	25.50	0.04	66.62			
Al	K series	0.10	0.02	0.15	Al_2O_3	0.18	0.03
Si	K series	3.74	0.02	5.56	SiO_2	7.99	0.05
Ti	K series	5.22	0.03	4.56	TiO_2	8.71	0.05
Cr	K series	0.14	0.02	0.12	Cr_2O_3	0.21	0.03
Sn	L series	65.30	0.05	23.00	SnO_2	82.90	0.07
Total		100.00		100.00		100.00	

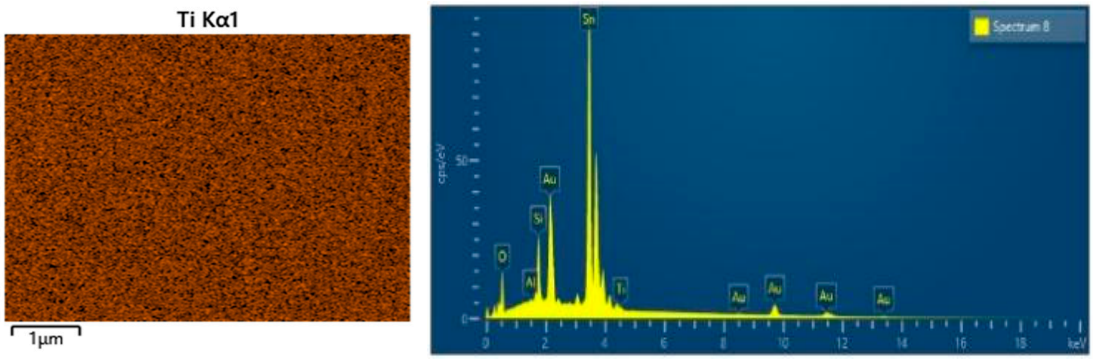


Figure S11. EDS analysis of sample CB_3

Table S8. Elemental percentage analysis of the sample CB_3

Element	Line Type	Weight %	Weight % Sigma	Atomic %	Oxide	Oxide %	Oxide % Sigma
O	K series	24.22	0.04	66.63			
Al	K series	0.12	0.02	0.20	Al_2O_3	0.23	0.04
Si	K series	4.23	0.02	6.63	SiO_2	9.05	0.05
Ti	K series	0.08	0.02	0.08	TiO_2	0.14	0.04
Sn	L series	71.35	0.05	26.46	SnO_2	90.58	0.07
Total		100.00		100.00		100.00	

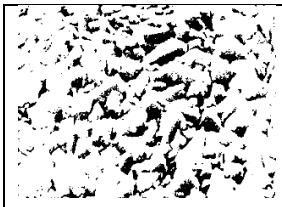
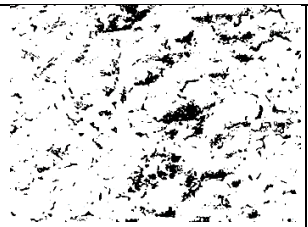
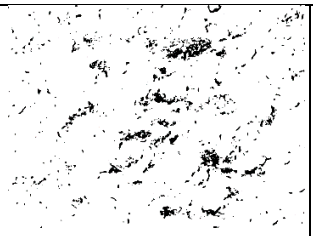
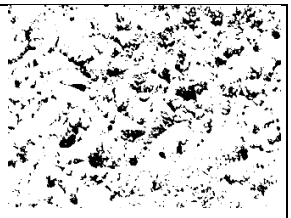
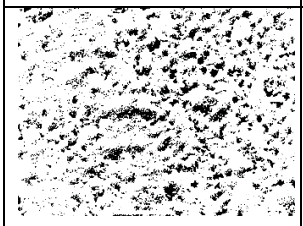
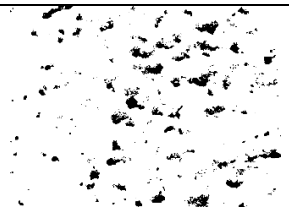
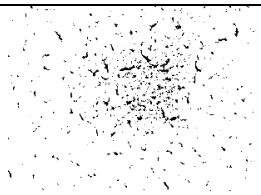
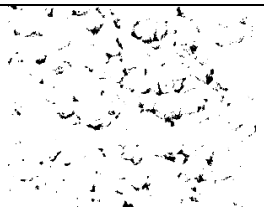
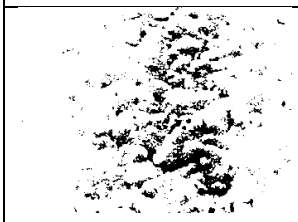
Table S9a. Elemental percentage analysis of the sample CB_5 in site 1

Element	Line Type	Weight %	Weight % Sigma	Atomic %	Oxide	Oxide %	Oxide % Sigma
O	K series	24.41	0.05	66.30			
Na	K series	0.33	0.04	0.62	Na_2O	0.44	0.05
Al	K series	0.21	0.02	0.34	Al_2O_3	0.40	0.04
Si	K series	4.19	0.03	6.49	SiO_2	8.97	0.05
Ti	K series	0.57	0.03	0.52	TiO2	0.95	0.04
Sn	L series	70.29	0.06	25.74	SnO2	89.25	0.08
Total		100.00		100.00		100.00	

Table S9b. Elemental percentage analysis of the sample CB_5 in site 2

Element	Line Type	Weight %	Weight % Sigma	Atomic %
O	K series	25.50	0.19	67.78
Na	K series	0.15	0.04	0.29
Al	K series	0.25	0.02	0.40
Si	K series	4.14	0.03	6.27
Ti	K series	0.37	0.02	0.33
Sn	L series	69.58	0.18	24.94
Total		100.00		100.00

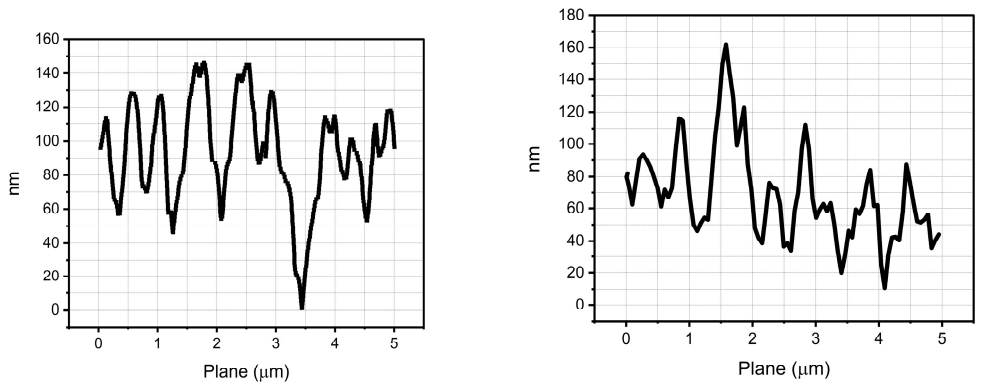
Table S10. Images obtained from SEM micrographs by using Fiji software, for determination of the FTO coverage (%) with TiO_2 films ; Black points correspond to uncovered areas of FTO substrate

			
SP_21 81.25%	SP_22 87.92%	SP_24 95.59%	SC_11 85.95%
			
SC_21 83.16%	CB_1 93.1%	CB_2 96.47%	CB_3 95.72%
			
CB_5 90.39%			

IV AFM ROUGHNESS

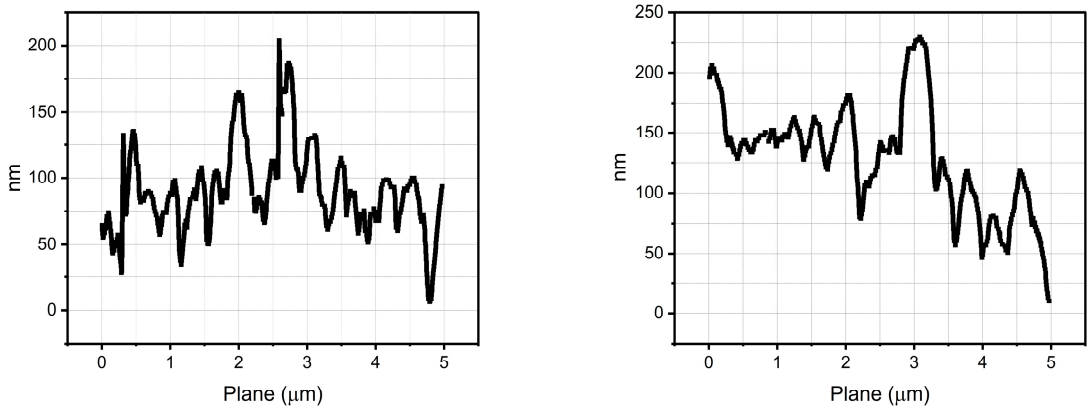
Table S11. Roughness values of the samples presented as average (Ra) and root mean square (RMS) roughness.

Sample name	Ra (nm)	RMS (nm)
FTO	20.50	28.38
SP_21	22.01	27.82
SP_22	24.17	30.33
SP_23	23.88	19.77
SP_24	34.92	43.82
SC_11	26.96	33.86
SC_33	53.56	75.93
CB_1	23.02	29.36
CB_3	29.07	36.49
CB_5	29.51	42.72
CB_6	30.43	38.08



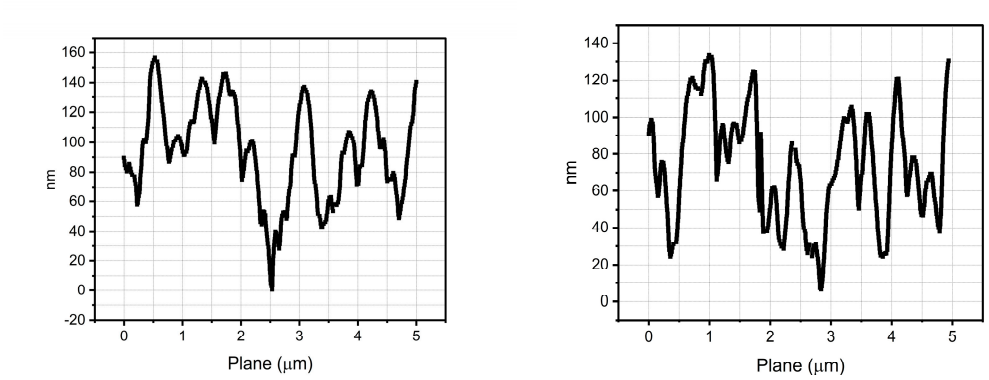
(a) (b)

Figure S12. The average roughness curves for bare FTO (a), and SP_21 sample (b) obtained with AFM.

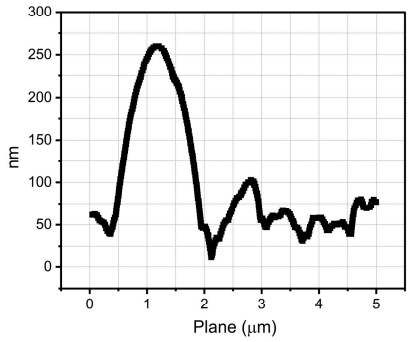


(a) (b)

Figure S13. The average roughness curves for SC_11 (a), and SC_33 (b) samples obtained with AFM.



(a) (b)



(c)

Figure S14. The average roughness curves for CB_1 (a), CB_3 (b) and CB_5 (c) samples obtained with AFM.

KPFM measurements

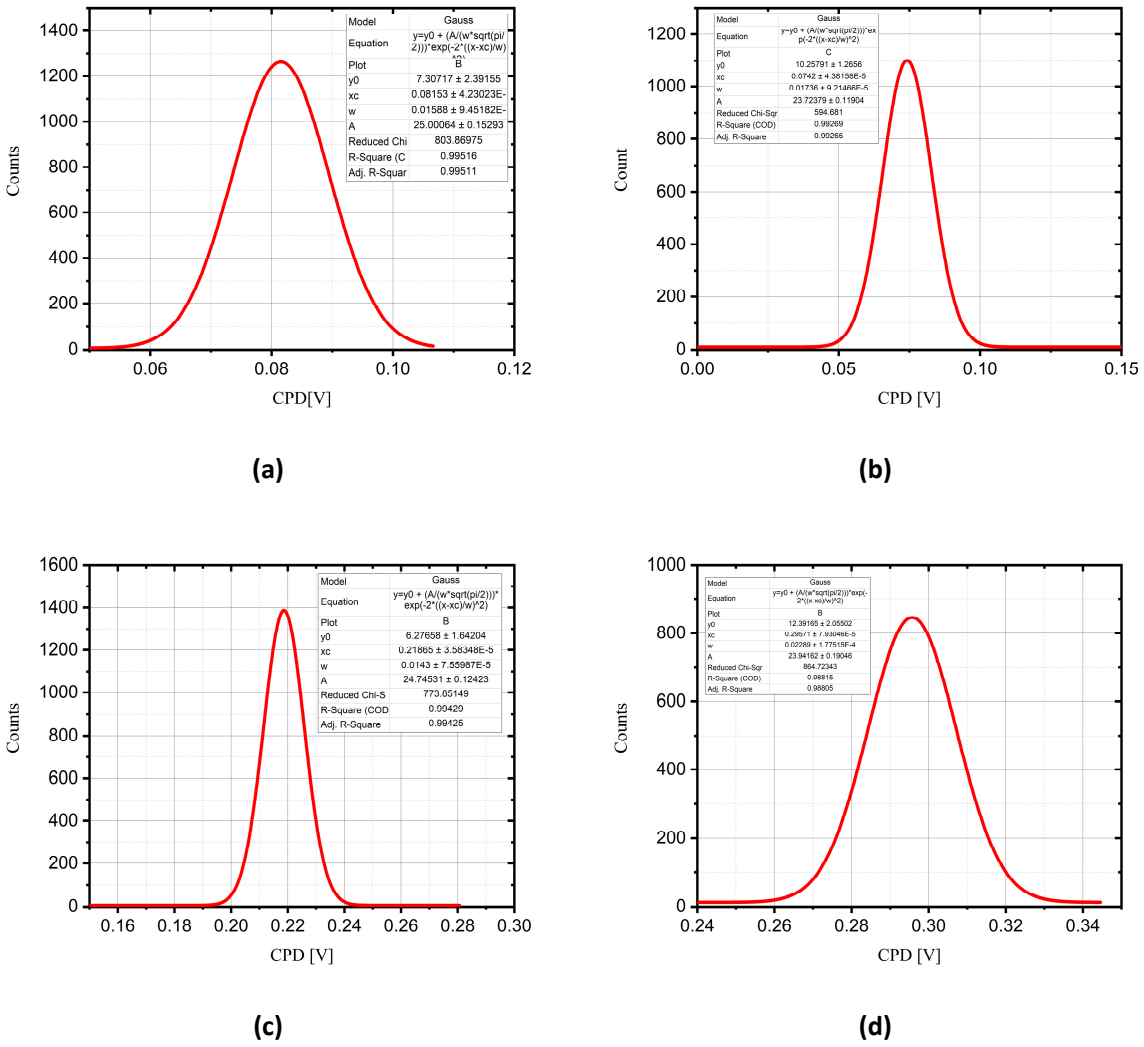


Figure S15. The CPD histogram distributions used for the evaluation of work functions of FTO (a), SP_23 (b), SC_33 (c), and CB_2 (d) samples.