Supplementary Information

Determination of the electrical parameters of iodine-doped polymer solar cells at the macro- and nanoscale for indoor applications

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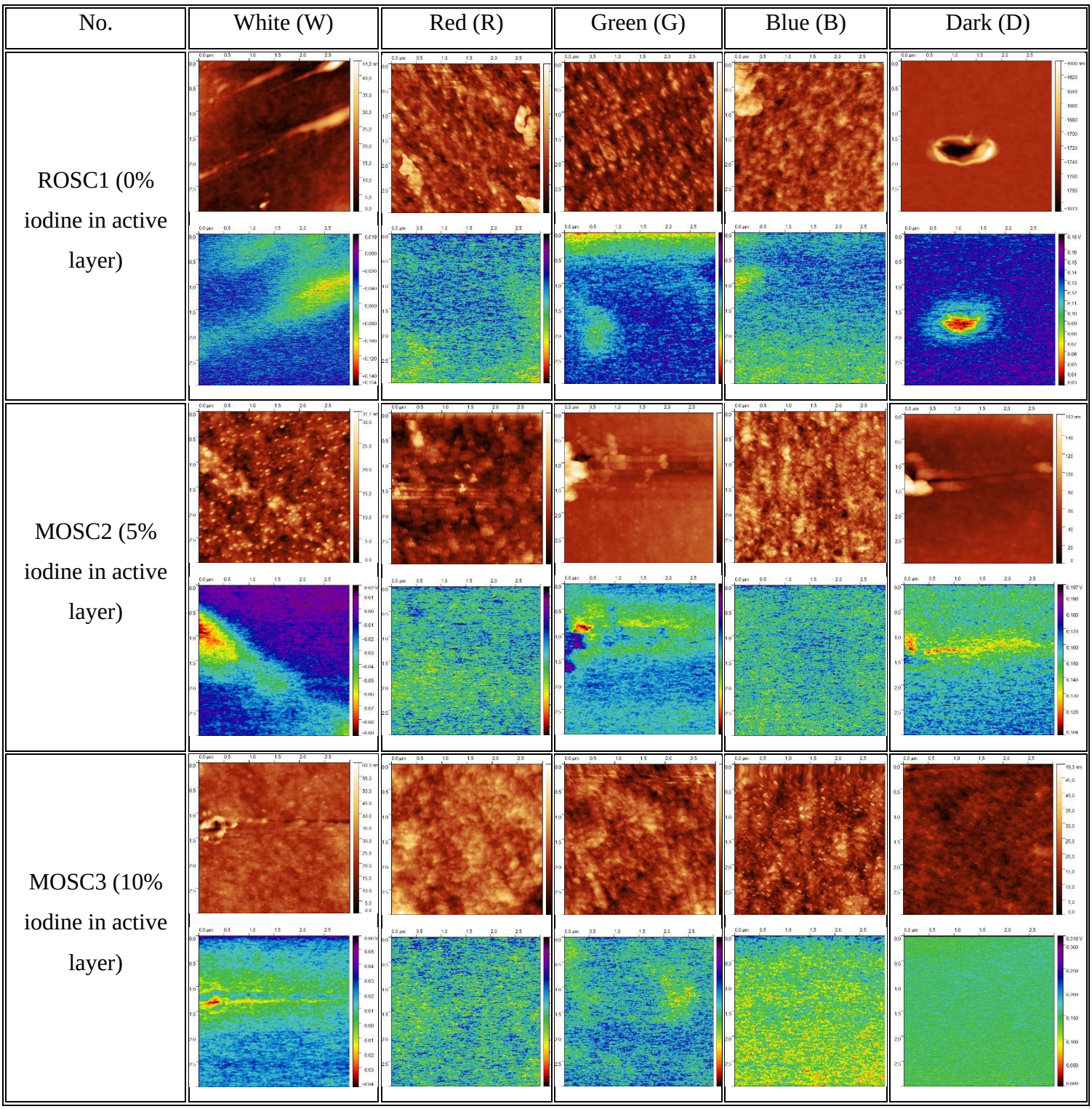

Figure S1. Topography (on the top, AFM) and surface potential (below, p-KPFM) of working half-cell photovoltaic devices based on an absorber P3HT:PCBM without (ROSC1) and with (MOSC2 and MOSC3) iodine doping.

The topography images (see Figure S1) were processed using following filters: tilt removal (flat surface), slow scanning axis drift removal (rows align), strokes removal. The SP images were processed with averaging filter (mean value), with window size 4x4 pixels, in order to increase image readability in terms of topography impact (features presence). In order to compare the outcome, the statistical analysis was performed. While some images contain artefacts related to the tip impact during the

approach, their presence was ignored (masked) during statistical analysis in order to avoid their impact on the obtained values and following analysis. One can see the artefacts that had to be avoided in quantitative analysis and natural features, that one should take into account, while their presence is not related to the investigation, and has an impact on the properties of materials of our interest. It has to be emphasized, that in order to be able to compare the measurement results, all the scanning parameters were maintained during the experiment. In particular, the configuration of SP detection modules was that same.

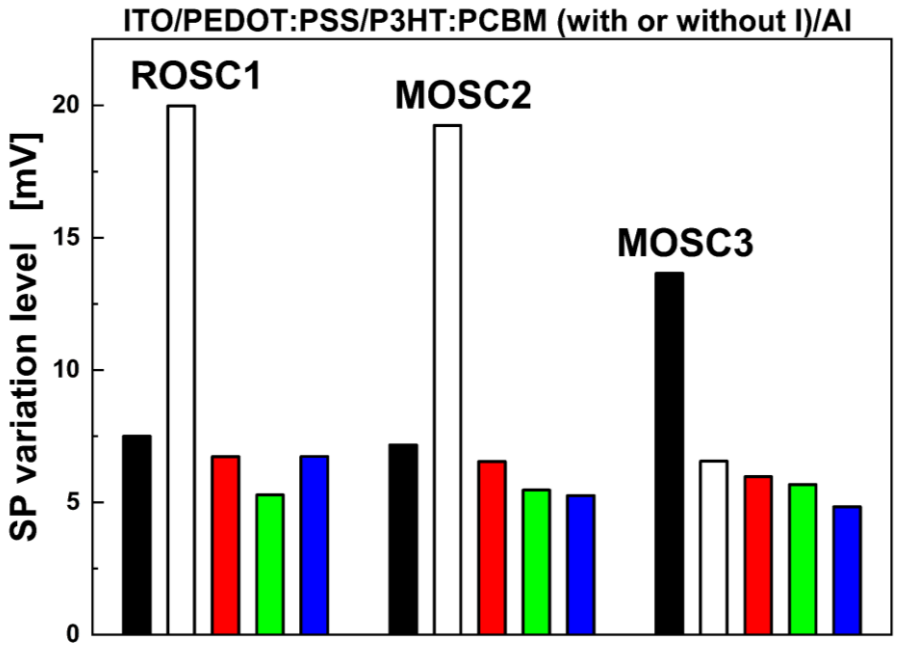

Figure S2. Values of the surface potential variation level obtained from p-KPFM of working half-cell photovoltaic devices in the dark and under different light sources.

Table S1. Morphological properties of investigated films. Sq (root mean square deviation), Sku (kurtosis), Ssk (skewness) and Sdq (root means square gradient) parameters for the measurements for the samples ROSC1, MOSC2, MOSC3.

Sample		S_q [nm]	S_{ku} [nm]	S_{sk} [nm]	S_{dq} [nm]
ROSC1 (0% iodine in active layer)	dark	1.374	0.423	0.092	0.089
	white	3.171	3.088	0.142	0.147
	red	1.356	1.687	1.103	0.053
	blue	1.546	1.548	0.811	0.065
	green	1.425	0.292	0.620	0.071
MOSC2 (5% iodine in active layer)	dark	4.820	-0.240	-0.200	0.113
	white	4.107	0.670	0.448	0.167
	red	2.544	1.027	0.724	0.111
	blue	2.188	0.298	0.315	0.116
	green	6.425	-0.805	0.191	0.127
MOSC3 (10% iodine in active layer)	dark	2.834	1.600	0.489	0.140
	white	3.081	1.020	0.446	0.190
	red	2.714	0.523	0.191	0.084
	blue	2.817	0.788	0.535	0.164
	green	2.299	0.156	0.311	0.088

Table S2. Summary of the EEC (a) modelling results for samples ROSC1, MOSC2 and MOSC3 in dark and illuminated states. Shown are: R_s – contacts and connections resistance, R_1 -$CPE1$ – parameters of R-CPE circuit related to τ_1 – diffusion time of electrons, R_2 - $CPE2$ – parameters of R-CPE circuit related to τ_2 – electron-hole recombination lifetime.

Sample		R_S [Ω]	ΔR_S [Ω]	R_1 [kΩ]	ΔR_1 [kΩ]	CPE1				R_2 [kΩ]	ΔR_2 [kΩ]	CPE2				τ_1 [µs]	$\Delta\tau_1$ [µs]	τ_2 [µs]	$\Delta\tau_2$ [µs]
						T [$s^P\Omega^{-1}$] × 10^{-9}	ΔT [$s^P\Omega^{-1}$] × 10^{-9}	P [–]	ΔP [–]			T [$s^P\Omega^{-1}$] × 10^{-9}	ΔT [$s^P\Omega^{-1}$] × 10^{-9}	P [–]	ΔP [–]				
ROSC1 (0% iodine in active layer)	dark	83.02	0.78	27.38	3.44	8.88	0.84	0.9498	0.0030	142.51	34.94	10.15	1.46	0.9545	0.0033	146.98	13.46	910.63	152.86
	white	89.38	2.19	0.78	0.12	39.06	10.00	0.8913	0.0212	16.85	4.70	81.43	5.66	0.8554	0.0073	8.15	1.25	457.71	161.37
	red	84.38	3.07	33.98	2.85	14.09	2.17	0.9060	0.0092	72.88	17.10	55.01	2.77	0.8956	0.0075	212.38	13.68	2090.00	477.42
	blue	88.06	2.65	1.33	0.14	41.30	10.40	0.8760	0.0216	21.12	5.17	86.67	6.08	0.8528	0.0075	12.99	0.88	627.93	202.69
	green	86.95	4.32	6.44	0.96	24.44	5.78	0.8884	0.0188	35.53	4.12	72.52	5.90	0.8640	0.0051	49.73	4.82	1020.00	188.86
MOSC2 (5% iodine in active layer)	dark	82.34	1.38	6.35	0.74	11.74	1.62	0.9575	0.0106	33.74	3.81	11.10	2.68	0.9287	0.0132	44.89	2.81	176.92	12.27
	white	92.10	4.41	1.44	0.66	36.33	6.08	0.9041	0.0132	9.22	0.99	24.69	9.76	0.9269	0.0150	16.66	5.05	109.84	18.51
	red	93.94	4.54	9.23	2.41	11.43	1.21	0.9537	0.0240	24.55	7.10	39.57	21.23	0.8823	0.0348	65.60	11.40	334.99	81.97
	blue	99.61	4.81	1.50	0.84	25.93	8.79	0.9567	0.0537	13.98	1.47	30.98	15.08	0.8931	0.0283	20.87	6.22	158.27	40.14
	green	96.02	4.02	4.38	1.61	12.93	1.11	0.9761	0.0293	23.49	6.15	35.87	18.84	0.8750	0.0295	42.13	6.48	265.61	57.11
MOSC3 (10% iodine in active layer)	dark	87.27	3.03	31.14	18.21	10.14	0.32	0.9419	0.0084	41.07	7.53	9.35	1.66	0.9589	0.0105	147.58	78.49	384.15	181.47
	white	98.66	6.42	2.56	0.62	82.61	36.09	0.8150	0.0163	9.87	2.26	17.06	2.34	0.9666	0.0089	24.15	1.70	126.49	37.41
	red	100.52	10.95	5.33	0.55	9.63	2.06	1.0000	0.0000	45.11	23.32	29.94	3.11	0.8520	0.0067	49.75	6.29	453.61	283.59
	blue	103.15	10.45	4.61	1.07	61.70	28.92	0.8253	0.0190	13.87	4.34	17.51	2.10	0.9755	0.0131	38.50	1.27	196.04	63.50
	green	100.72	11.45	5.30	2.09	18.36	9.25	0.95	0.05	32.45	10.16	22.12	2.33	0.89	0.03	48.53	16.32	340.95	195.01

The average goodness of fit measure χ^2 of fitted spectra was 3.6E-4 and it span from 6.4E-5 to 1.5E-3 for individual measurements.
Rs - average series resistance related to the contacts and connections,
R_1 – CPE1/R_2 - CPE2 – parameters of R-CPE circuit related to τ_1 – average diffusion time of electrons/τ_2 – average electron-hole recombination lifetime
where:
- R_1/R_2- average resistance, $CPE1$/CPE2 – constant phase element,
- T and P, are average parameters of constant phase element

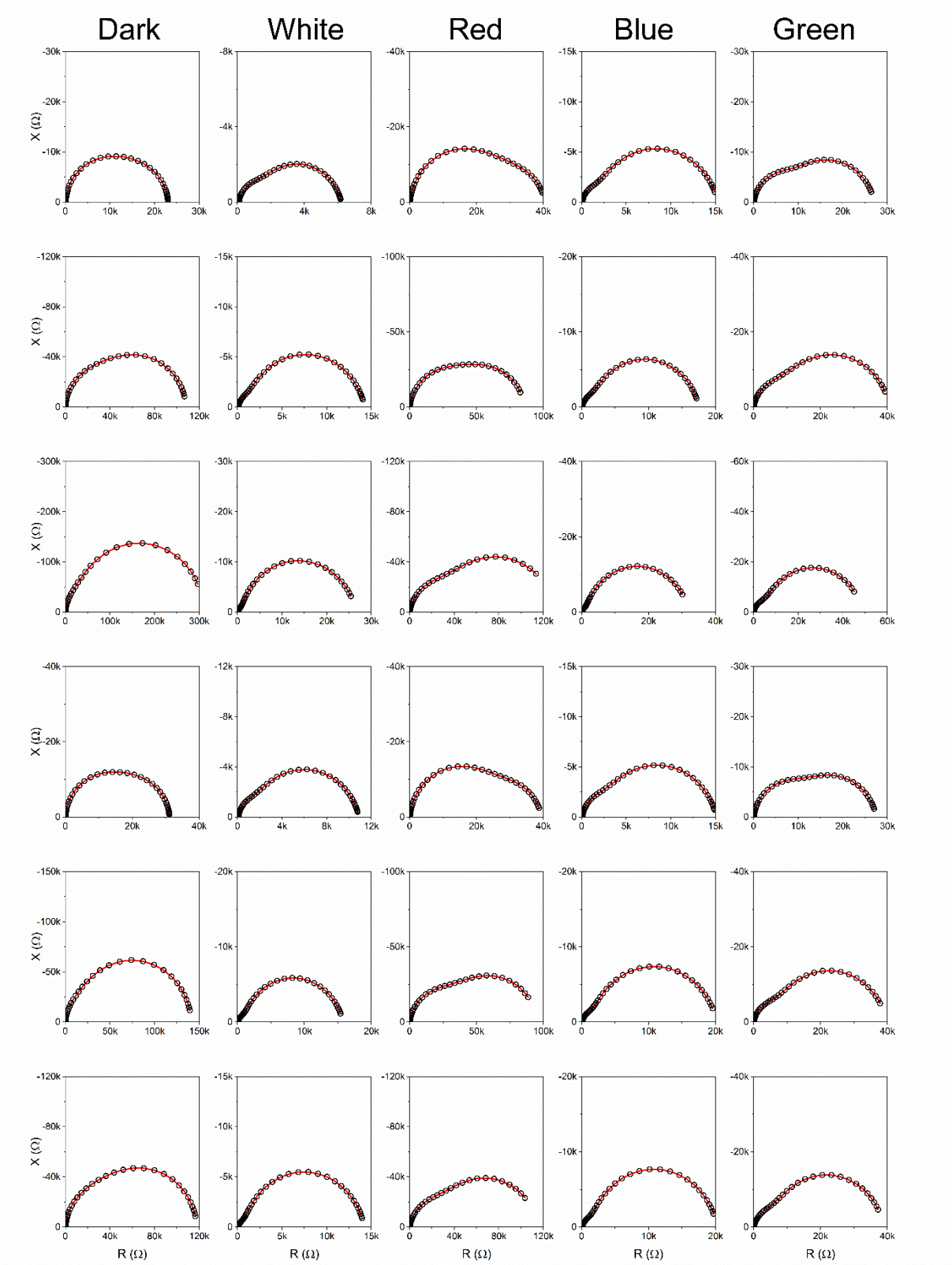

Figure S3. Measured (dots) and fitted (line) impedance spectra for 6 pixels (in rows) in ROSC1 sample measured in darkness and illumination.

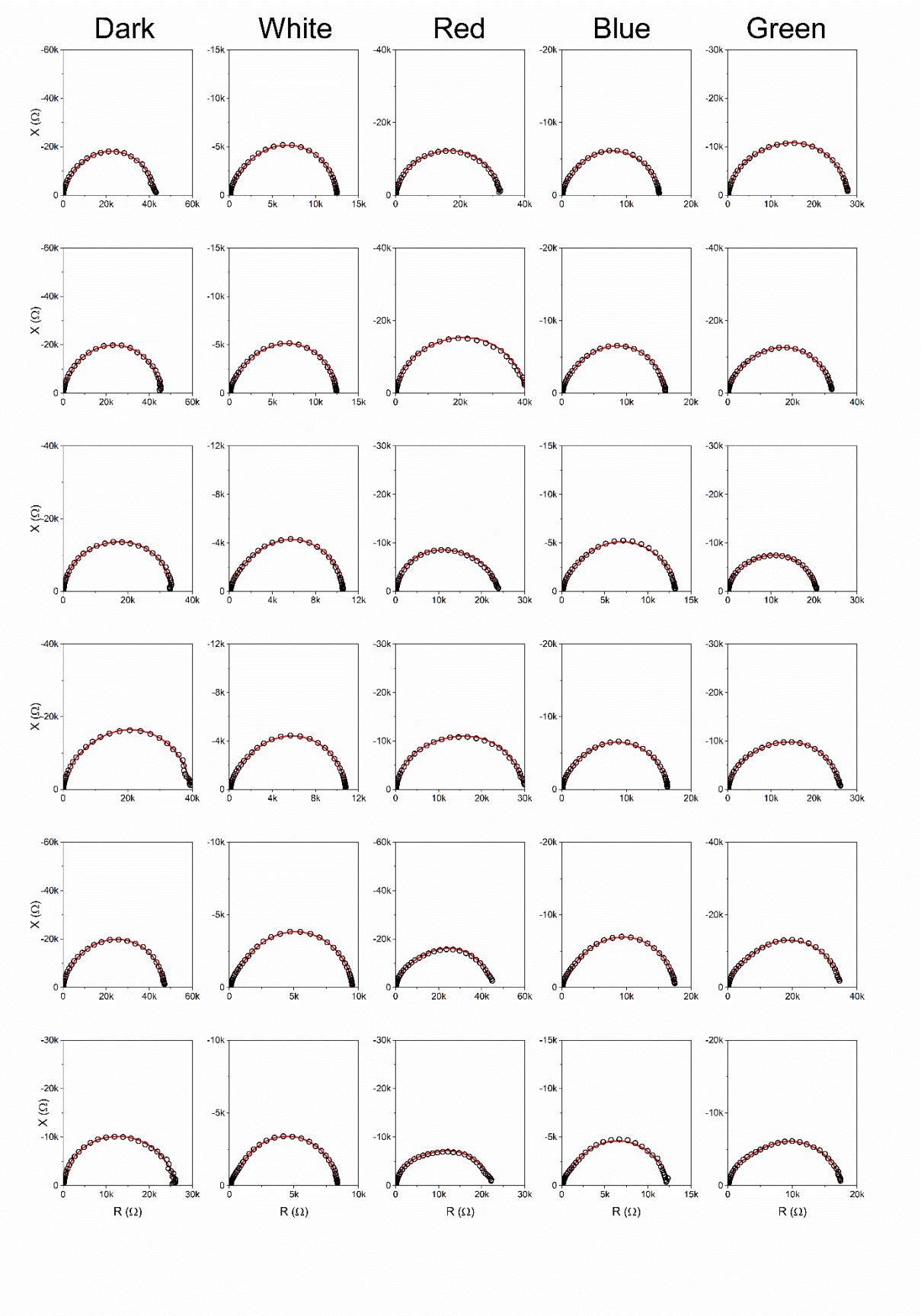

Figure S4. Measured (dots) and fitted (line) impedance spectra for 6 pixels (in rows) in MOSC2 sample measured in darkness and illumination.

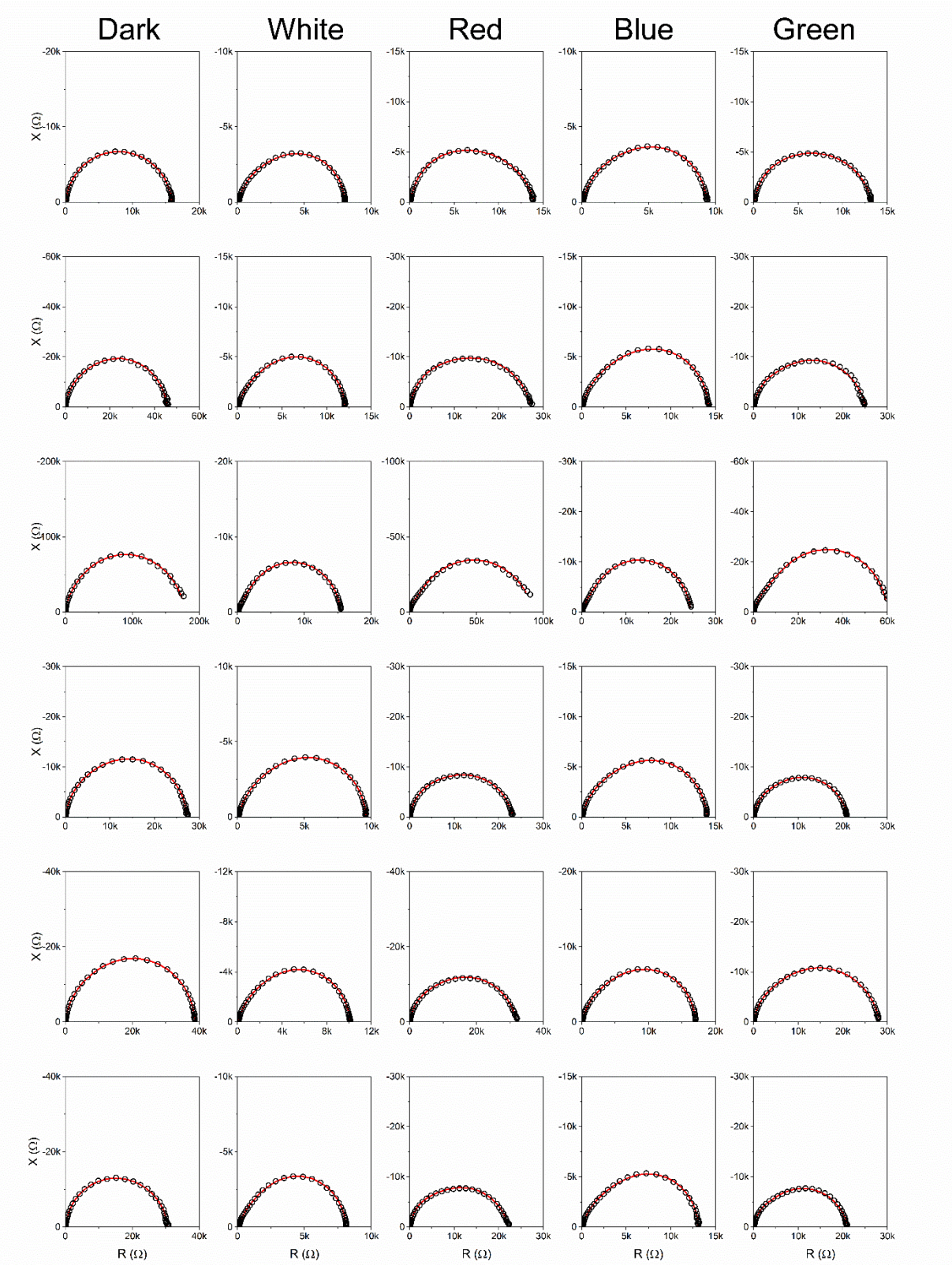

Figure S5. Measured (dots) and fitted (line) impedance spectra for 6 pixels (in rows) in MOSC3 sample measured in darkness and illumination.