Supporting information

for

Comparison of TiO_2 and ZnO solar cells sensitized with an indoline dye: time-resolved laser spectroscopy studies of partial charge separation processes.

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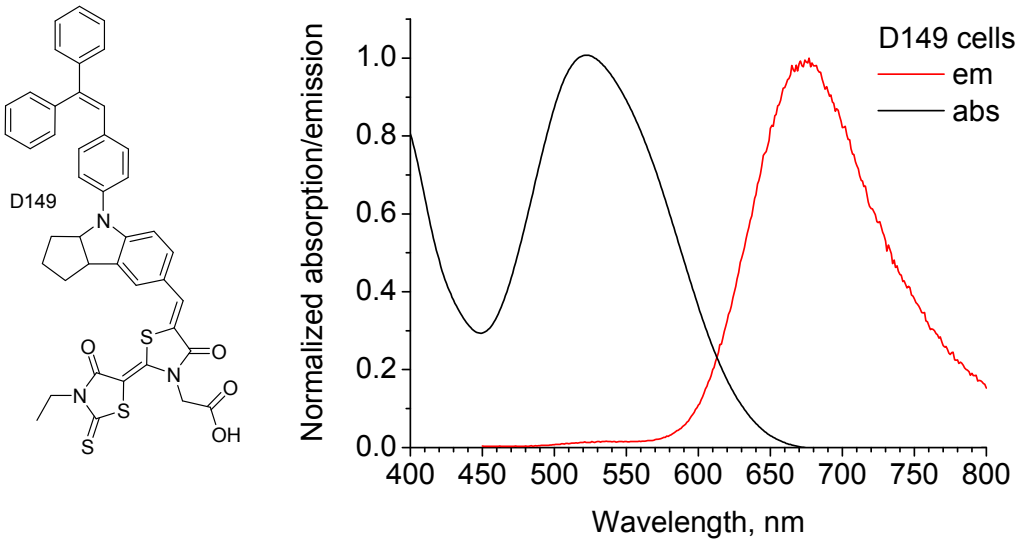
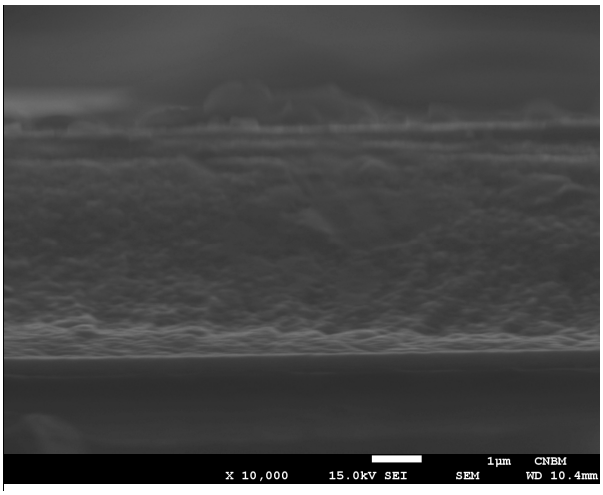
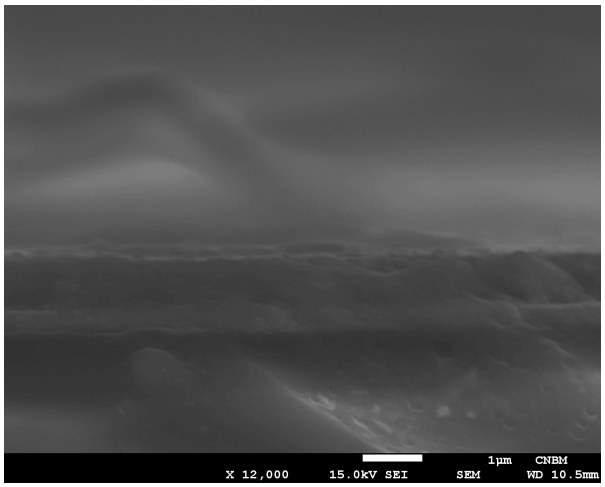


Figure S1. Structure of D149 dye (left) and selected stationary absorption and emission (after excitation at 425 nm) spectra (right) of complete DSC devices made with D149 dye.

(A)



(B)



(C)

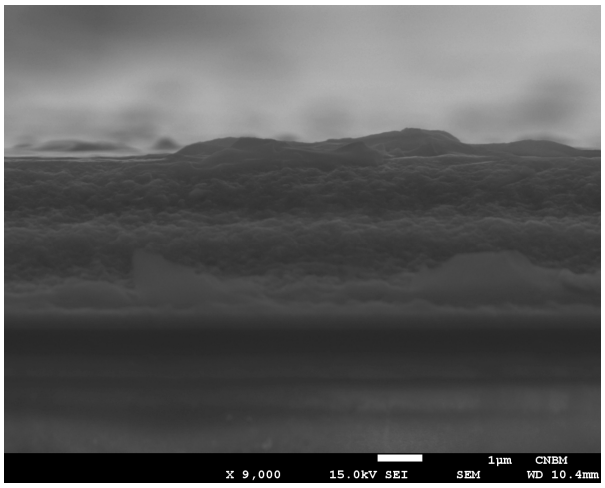
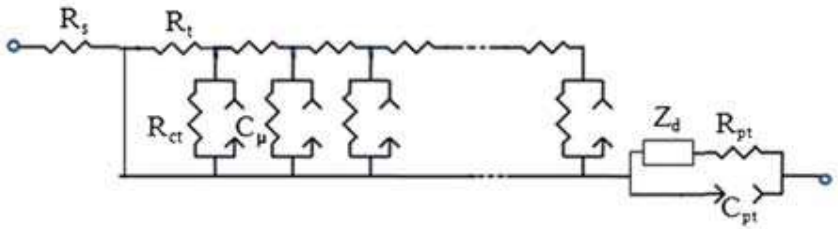


Figure S2. SEM pictures of cross-sections of working electrodes of: (A) TiO_2 cell, (B) ZnO cell, (C) TiO_2 "diluted" cell.

Results of electrochemical impedance spectroscopy studies

The fits to the typical equivalent circuit used for DSC studies for selected polarizations from 0 V to 0.6 V (presented in Figure S3) yielded the transport resistance (R_t), charge transfer resistance (R_{ct}) and chemical capacitance (C_μ) in the oxide-electrolyte interface. These parameters are collected in Table S1. The electron recombination lifetime (calculated as $R_{ct}C_\mu$) is longer for the ZnO solar cell than for the TiO_2 one. This might be due to lack of a blocking layer between working electrode and electrolyte, which usually contributes to the recombination at low V_{OC} [S1]. The relative transport diffusion length (calculated as $(R_{ct}/R_t)^{1/2}$ in units of film thickness) is always longer for ZnO sample (for example 20 vs. 12 at 0.5 V and 7.5 vs. 1.5 at 0.6 V). However, for both samples and all voltages applied, the relatively diffusion length is much larger than one, which is an evidence of good collection efficiencies in the photoanodes.

Equivalent circuit of DSC used to fit electrochemical impedance data:



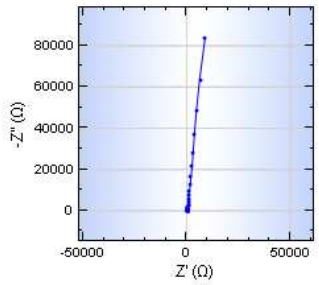
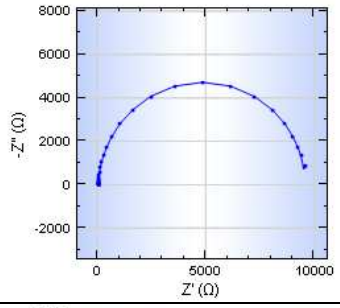
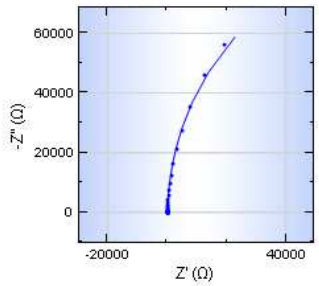
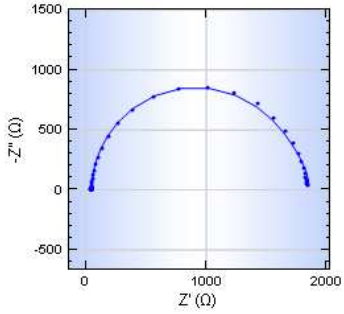
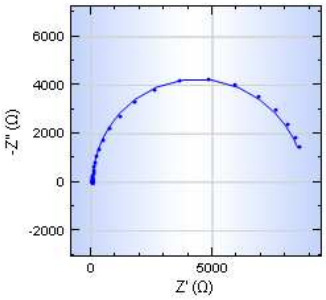
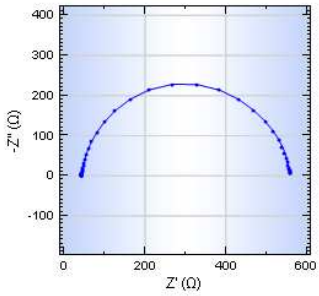
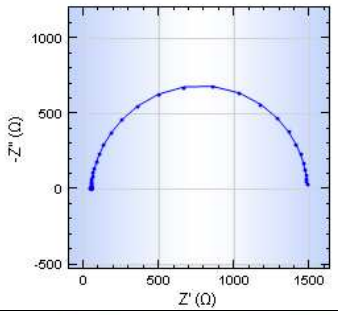
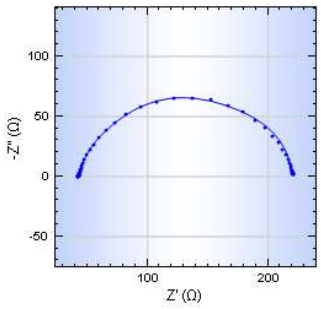
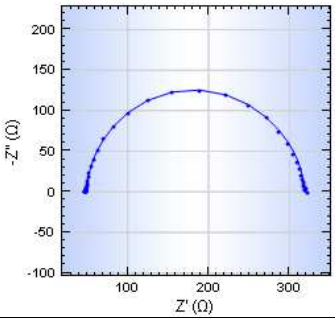
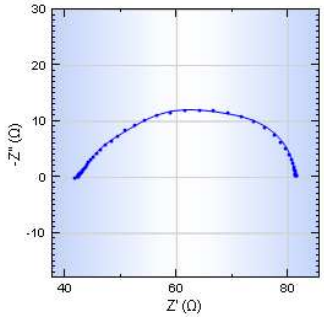
Voltage, V	ZnO	TiO_2
0		
0.2		
0.4		
0.5		
0.6		

Figure S3. Fits to complex plain impedance plots with parameters given in Table S1.

Table S1. Parameters of the fits of the equivalent circuit (presented above) and potentials applied from 0 V to 0.6 V for (A) ZnO and (B) TiO_2 solar cell: transport resistance (R_t), charge transfer resistance (R_{ct}) and chemical capacitance (C_μ) in the oxide-electrolyte interface. The fits are shown in Figure S3.

(A) ZnO

Voltage, V	R_t, Ω	R_{ct}, Ω	C_μ, μF	$R_{ct}\,C_\mu$, ms	$(R_{ct}/R_t)^{1/2}$
0	--	1.15×10^6	18.9	21 700	--
0.2	20.5	1.75×10^5	24.1	4 200	92
0.4	1.35	8 300	30	249	78
0.5	3.21	1 300	36.5	47	20
0.6	4.1	231	39.9	9.2	7.5

(B) TiO_2

Voltage, V	R_t, Ω	R_{ct}, Ω	C_μ, μF	$R_{ct}\,C_\mu$, ms	$(R_{ct}/R_t)^{1/2}$
0	--	9300	13.5	126	--
0.2	--	1650	15.9	26	--
0.4	--	408	27.2	11	--
0.5	0.7	95	58.2	5.5	11.6
0.6	2.15	5.1	104	0.53	1.5

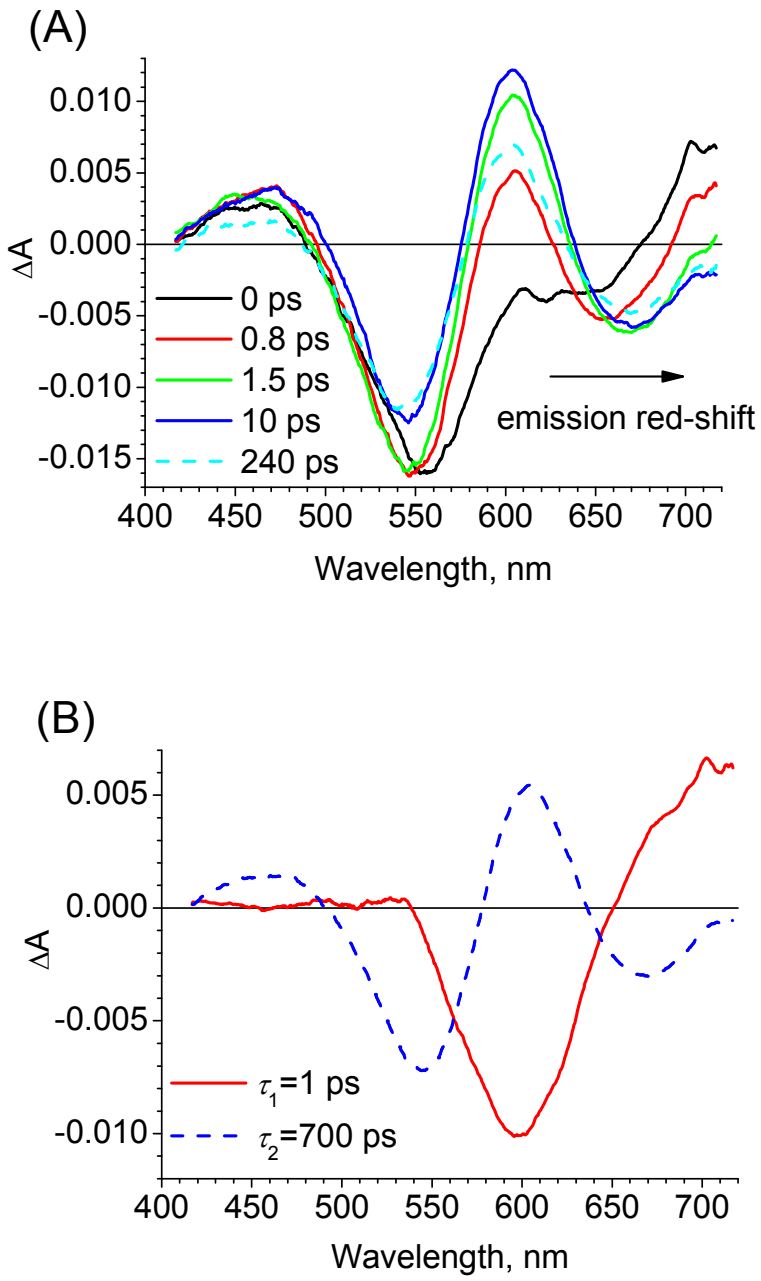


Figure S4. (A) Transient absorption spectra of D149 in DCM for selected, indicated time delays between the pump (at 550 nm) and probe pulses. The arrow shows the direction of the temporal changes. (B) The wavelength-dependent amplitudes of the components, having time constants given in the inset obtained by a multi-exponential global fit for D149 in DCM.

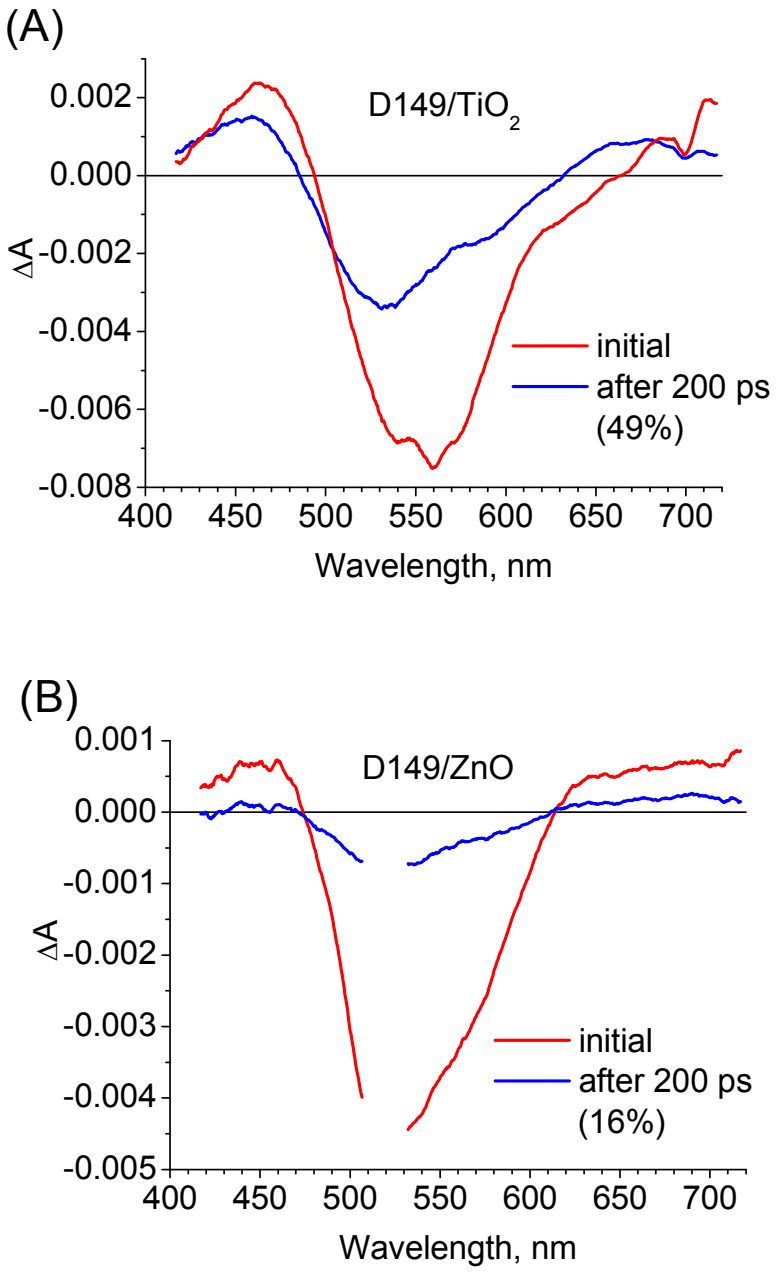


Figure S5. Comparison of transient absorption spectra of (A) D149/TiO_2 and (B) D149/ZnO solar cell for 0 ps (initial) and 200 ps delay time between the pump (at 550 nm) and probe pulses.

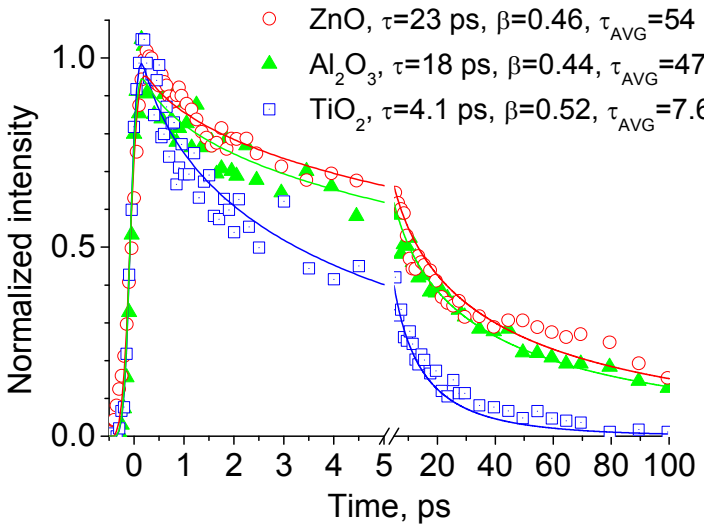


Figure S6. Femtosecond emission transients measured with up-conversion setup of IRF=300 fs (FWHM). The emission was observed at 660 nm, and upon excitation with 500 nJ/cm^2 pulses at 580 nm. The solid lines are from the best fit using the convolution of IRF of the setup with a stretched exponential function given by eq. (6) and (7) and the parameters given in the inset.

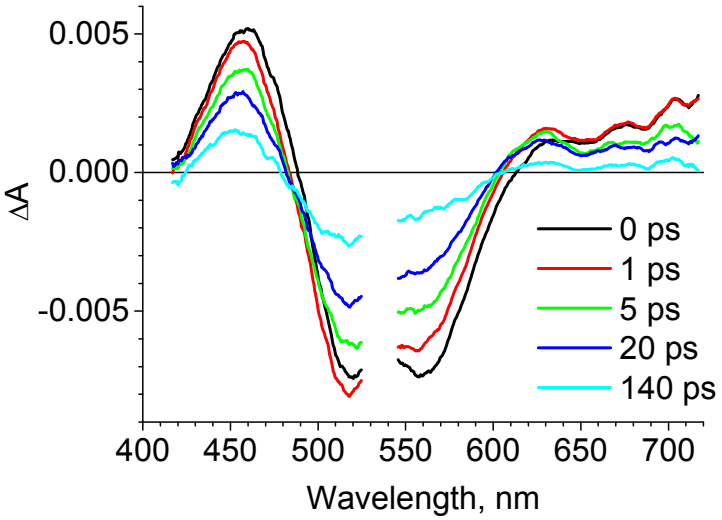


Figure S7. Transient absorption spectra of D149/Al_2O_3 for selected, indicated time delays between the pump (at 530 nm) and probe pulses.