SUPORTING INFORMATION

Optical Optimization of the TiO_2 Mesoporous Layer in Perovskite Solar Cells by the Addition of SiO_2 Nanoparticles

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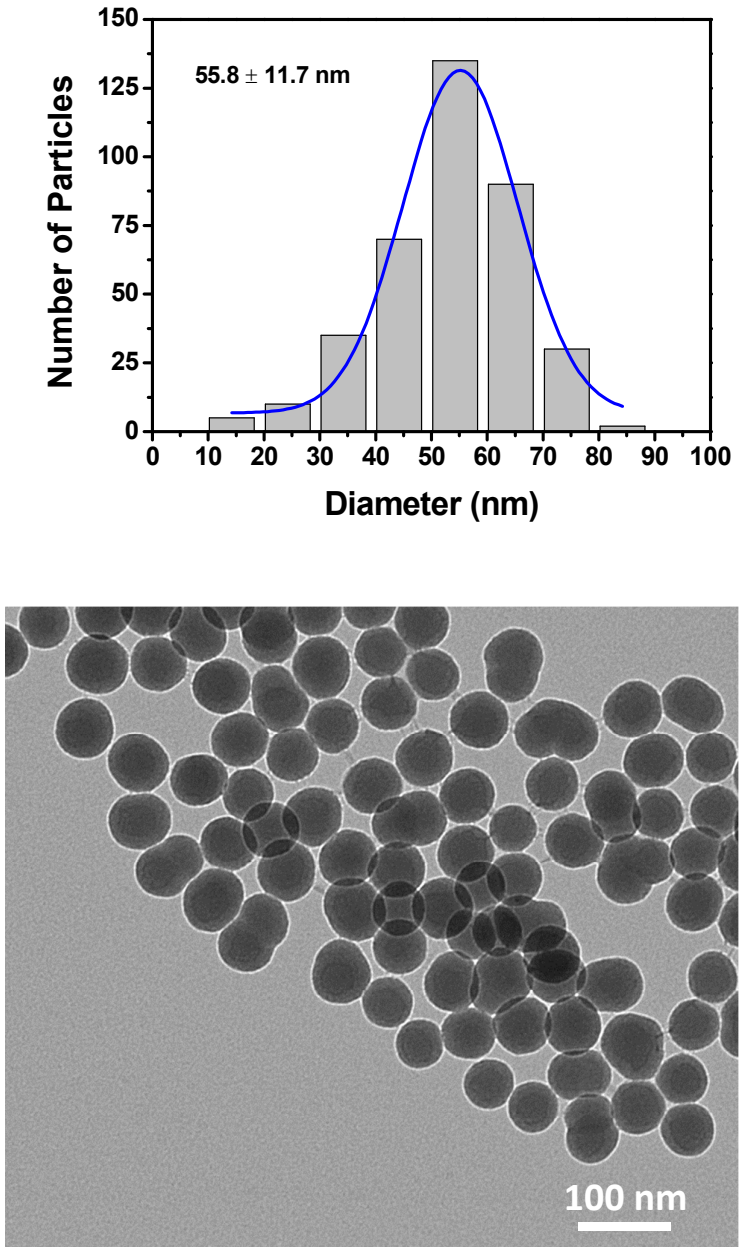
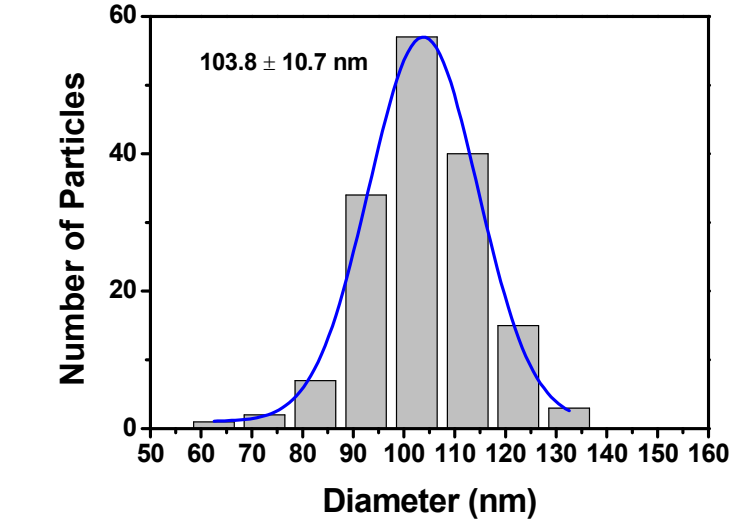


Figure S1. Size histogram (top) and TEM image (bottom) of SiO_2 NPs with 50 nm size.



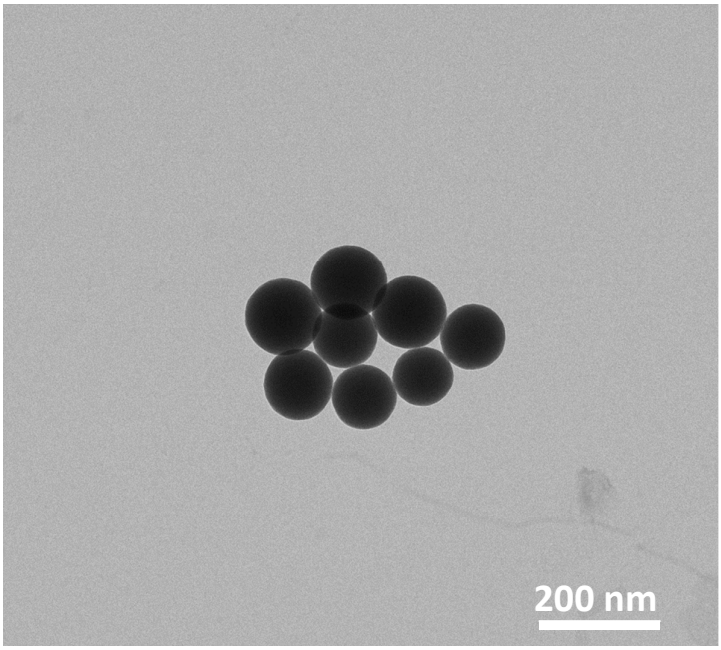


Figure S2. Size histogram (top) and TEM image (bottom) of SiO_2 NPs with 100 nm size.

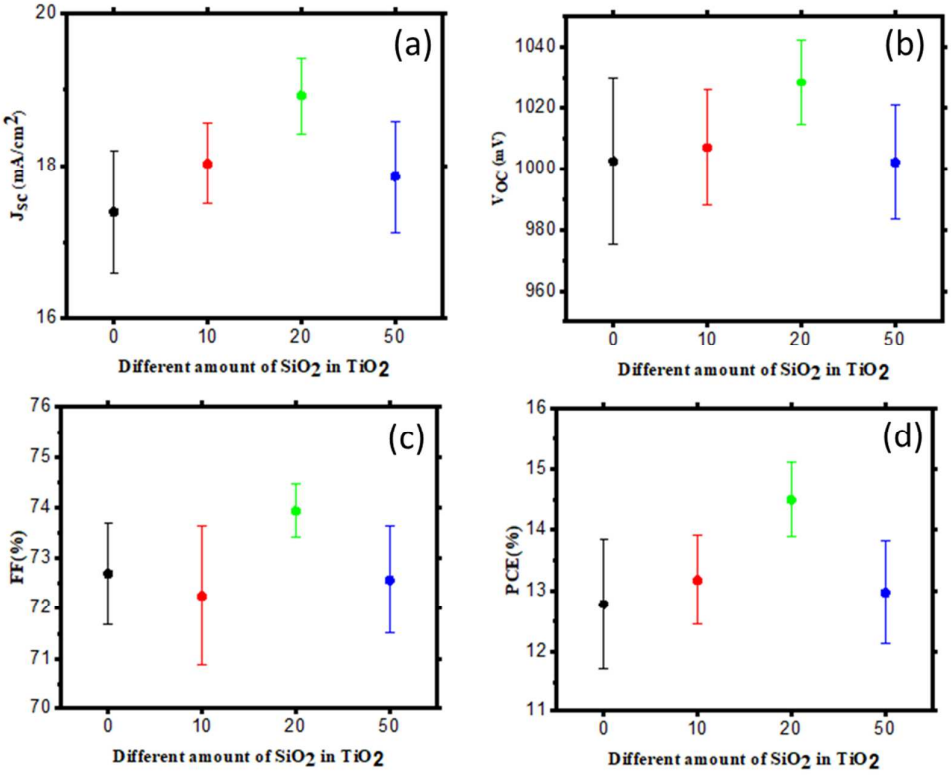


Figure S3. 90% confidence interval for the mean of photovoltaic performance for cells using different concentrations of SiO_2 NPs of 50nm size (a) J_{sc}, (b) V_{OC}, (c) FF, (d) PCE.

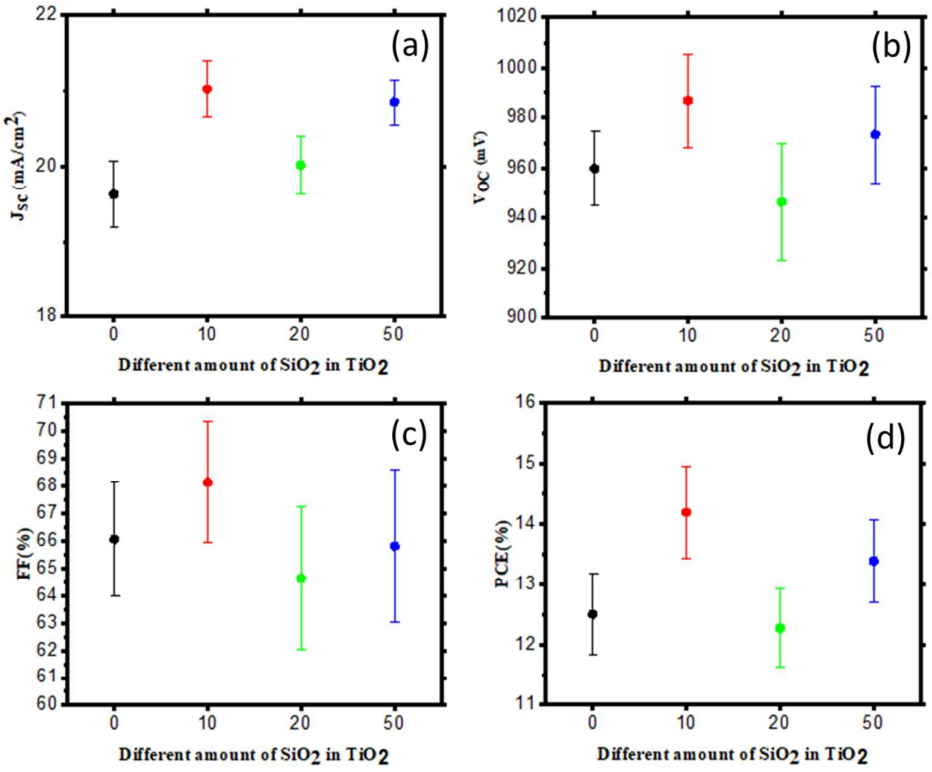


Figure S4. 90% confidence interval for the mean of photovoltaic performance for cells using different concentrations of SiO_2 NPs of 100nm size (a) J_{sc}, (b) V_{OC}, (c) FF, (d) PCE.

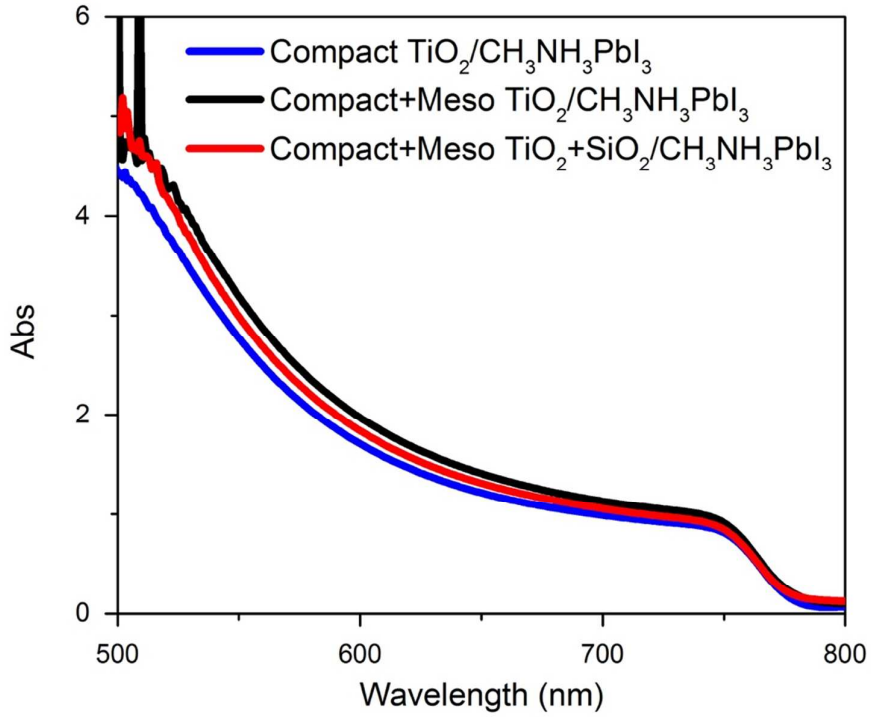


Figure S5. Absorption measurement of $Ch_3NH_3PbI_3$ layer deposited on top of FTO/Compact TiO_2, FTO/Compact TiO_2/Mesoporous TiO_2 and FTO/Compact TiO_2/Mesoporous TiO_2+SiO_2 substrates. Layers deposited on mesoporous substrates exhibit higher absorption due to the higher thickness of the deposited layer, samples with SiO_2 show a slight decrease of absorption probably as the size of SiO_2 reduce the effective porosity of the mesoporous layer. Absorption data is the average of the absorption spectra recorder for three different samples prepared at the same conditions.

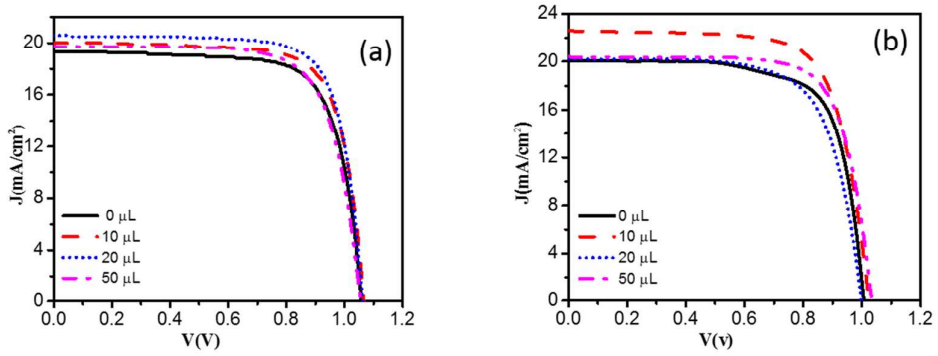


Figure S6. J–V curves under simulated AM1.5 light for perovskite solar cells with different concentrations of SiO_2 NPs (0, 10, 20, 50 µL) and different particle sizes (a) 50 nm, (b) 100 nm.

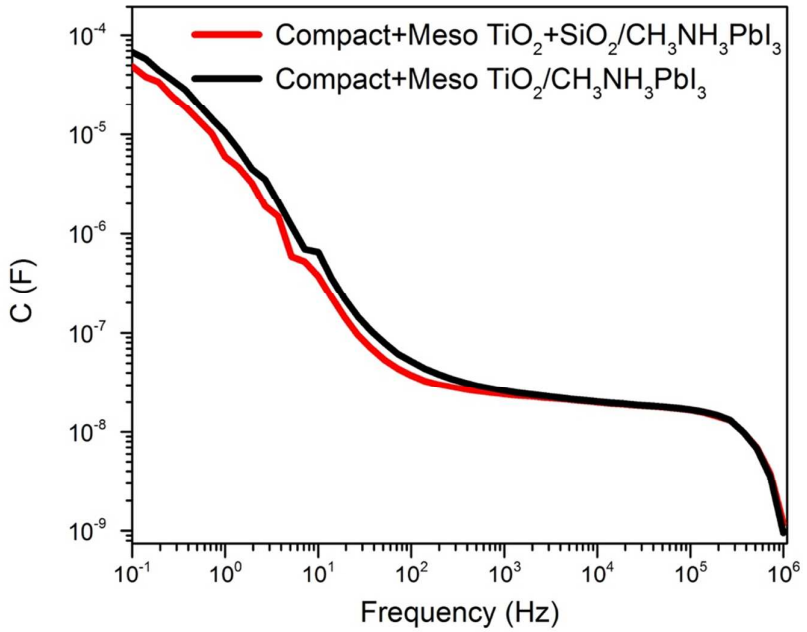


Figure S7. Bode plot of the real part of capacitance of cells with and without SiO_2 NPs of 100 nm size (10 µL of a solution of 0.4 mg of SiO_2 powder in 10 mL of ethanol). Measurement have been performed at 0 applied bias under 1 sun illumination.

Table S1. Average values of J_{sc}, V_{oc}, FF, and PCE for Perovskite Solar Cells with different concentrations SiO_2 NPs (50 nm) under the Irradiation of 1 sun Intensity (100 $mW.cm^{-2}$; AM 1.5G) measured at reverse sweep (RS) and forward sweep (FS) directions

SiO_2 (µL)	sweep direction	J_{sc} (mA/cm^2)	V_{oc} (v)	FF (%)	PCE (%)
0	RS	17.39± 1.94	1.002± 0.055	72± 1	12.77± 2.17
	FS	16.89±1.89	0.986±0.137	67±7	11.49±2.90
10	RS	18.03± 1.29	1.007± 0.043	72± 2	13.17± 1.67
	FS	18.11±1.02	1.016±0.069	67±7	12.50±2.21
20	RS	18.63± 1.65	1.028± 0.036	73± 1	14.16± 1.8
	FS	18.28±1.63	1.037±0.04	69±2	13.34±1.89
50	RS	17.85± 1.78	1.002± 0.045	71± 3	12.96± 2.08
	FS	17.66±1.72	1.007±0.049	69±3	12.48±2.10