Electronic Supplementary Information for

Synergistic Strategies for the Preparation of Highly Efficient Dye-Sensitized Solar Cells on Plastic substrates: Combination of Chemical and Physical Sintering

Yuelong Li[a,b‡], Kicheon Yoo[a,c‡], Doh-Kwon Lee[a,d], Jin Young Kim[a], Hae Jung Son[a], Jong Hak Kim[c], Chul-Ho Lee[e], Hernán Míguez[b], Min Jae Ko[a,d,e*]*

[a]*Photo-Electronic Hybrids Research Center, Korea Institute of Science and Technology, Seoul 02792, Republic of Korea*

[b]*Instituto de Ciencia de Materiales de Sevilla, Consejo Superior de Investigaciones Científicas, Avda. Américo Vespucio 49, 41092 Sevilla, Spain.*

[c]*Department of Chemical and Biomolecular Engineering, Yonsei University, 120-746, Korea*

[d]*Green School, Korea University, 145, Anam-ro, Seongbuk-gu, Seoul 02841, Korea*

[e]*KU-KIST Graduate School of Converging Science and Technology, Korea University, Seoul 02841, Republic of Korea*

*Corresponding Authors:

Dr. Min Jae Ko, Tel.: +82-2-958-5518. Fax: +82-2-958-6649. E-mail: mjko@kist.re.kr

Dr. Hernán Míguez, Tel.: +34-954-489-581. Fax: +34-954-460-665. E-mail: h.miguez@csic.es

‡These authors contribute equally to this work

Experimental

The surface area and pore distribution properties were analyzed (Quantachrome NOVA 2000e analyzer) after the samples were degassed in vacuum at 250 °C for 2 h. The pore volume and size distributions were measured using the Barrett-Joyner-Halenda (BJH) method. Atomic force microscopy images are recorded on an XE-100 (Park systems, Korea) with PPP-NCHR 10M cantilever in the non-contact tapping mode.

Results

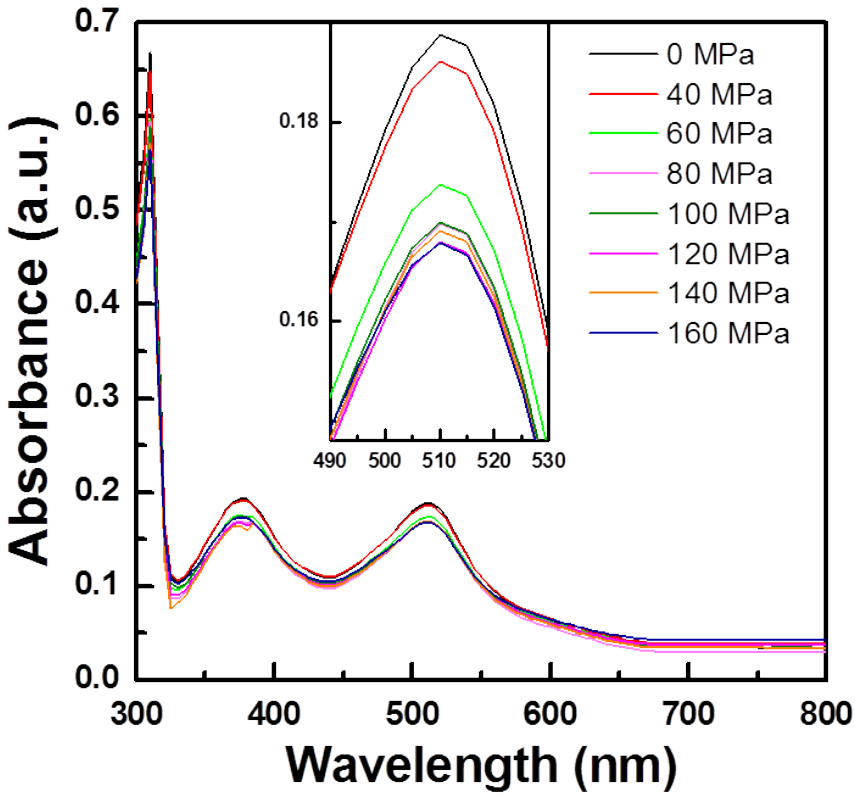

Figure S1 Absorbance spectra of dye molecules in basic solution ($NaOH/H_2O$, 50/50=V/V) desorbed from compressed films. The absorbance at wavelength of 510 nm is extracted for calculation of dye loading amount taking account of film thickness and area. The inset is enlarged spectra in the range of 490-530 nm.

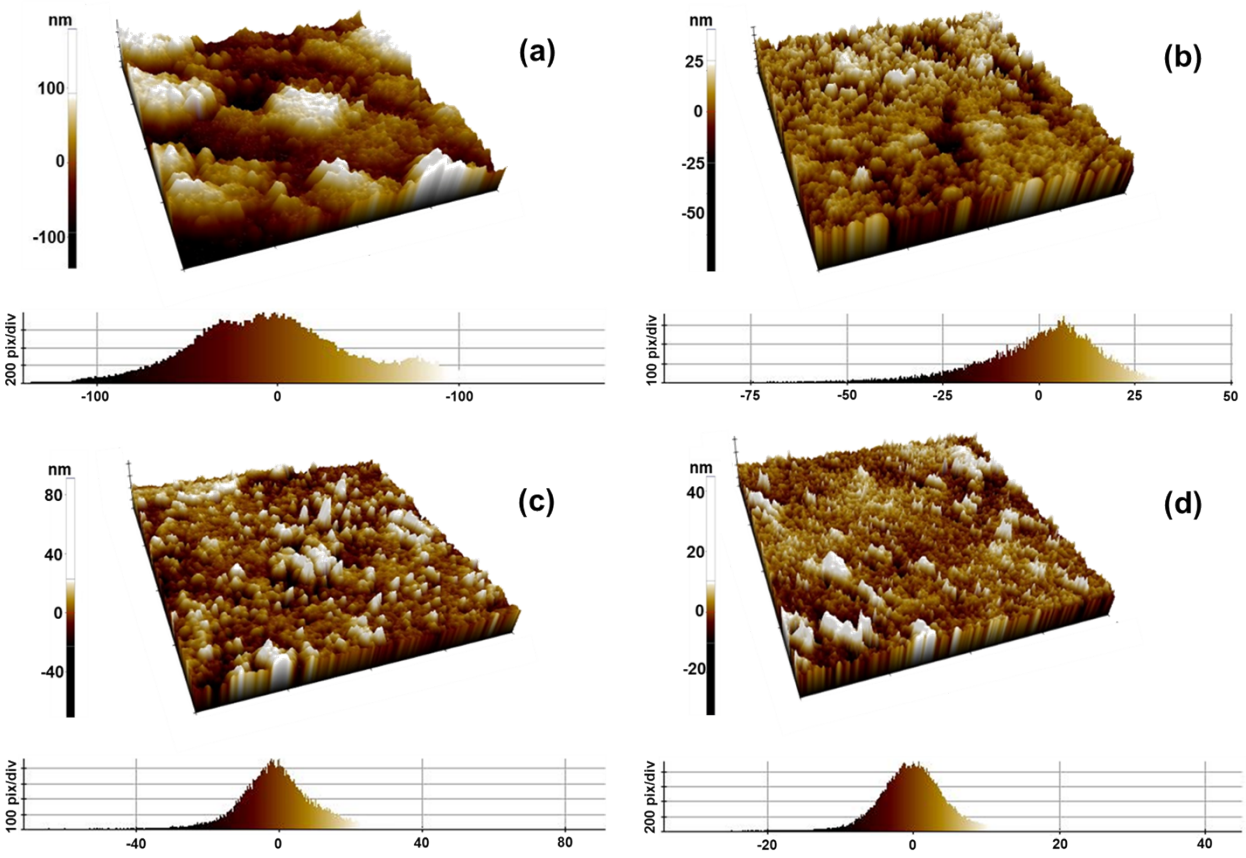

Figure S2 Three-dimensional atomic force microscopy (3D AFM) images of films compressed at 0 MPa in (a), 40 MPa in (b), 100 MPa in (c) and 160 MPa in (d), respectively. The histogram of roughness for the TiO_2 film was displayed as well. The root mean square roughness (R_q) are 47.66 nm, 15.95 nm, 11.71 nm and 5.27 nm for films compressed 0 MPa, 40 MPa, 100 MPa and 160 MPa, respectively. The area of each 3D AFM image is fixed at 4 μm × 4 μm.

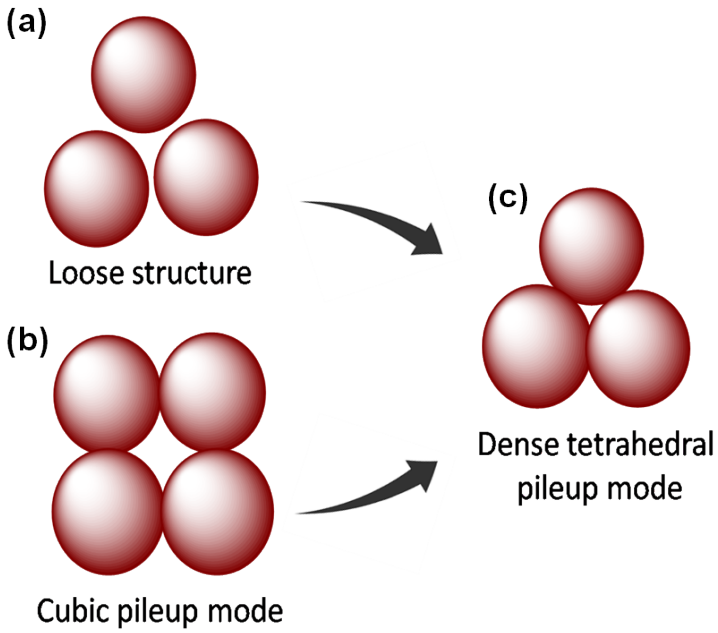

Figure S3 Pileup modes of TiO_2 nanoparticles before in (a), (b) and after compression in (c).

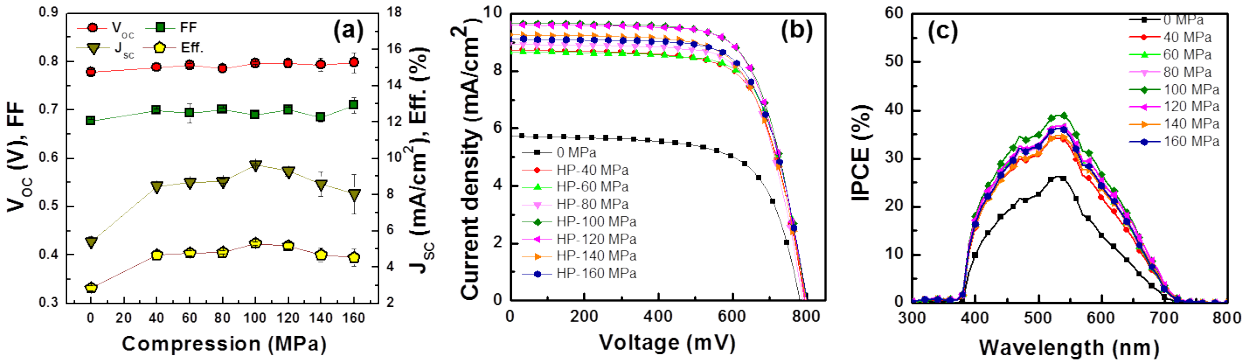

Figure S4 Photovoltaic properties in (a), photocurrent-voltage curves in (b), and IPCE in (c) of cells with compressed films at various compression force. The electrolyte is composed of 0.7 M PMII, 0.03 M I_2, 0.05 M GuSCN and 0.5 M tBP in a mixture of acetonitrile and valeronitrile (v/v = 85:15). The data is averaged from at least three points. IPCE was recorded without bias light.

Table S1 Structural properties of compressed films obtained from BJH analysis.

MPa	Total pore volume (cm^3/g)	Average pore diameter (nm)	Porosity (%)
0	0.18	5.12	41.8
40	0.13	3.32	34.0
100	0.09	2.69	25.6
160	0.08	2.36	22.8

Table S2 Comparison of different sintering effect on cell performance. Cells are prepared with same films but different post-treatments.

Sample	J_{sc} (mA/cm^2)	V_{oc} (V)	FF	η (%)
As-dried	5.73	0.782	0.68	3.02
Chemical sintered	7.85	0.785	0.73	4.50
Hot compressed	9.67	0.799	0.70	5.38

Table S3 The fitted and calculated results from impedance spectra of cell prepared with various compression forces. The equivalent circuit was beneath.

Sample	R_S	R_1	R_2	W_1	D_R (cm^2/s)
	($\Omega\ cm^2$)				
0 MPa	3.00	5.82	2.19	1.37	4.06×10^{-5}
40 MPa	2.93	2.35	3.66	1.81	1.99×10^{-5}
100 MPa	3.38	1.89	4.09	1.80	2.30×10^{-5}
160 MPa	3.06	2.40	3.40	2.93	1.30×10^{-5}