Electronic Supplementary Material (ESI) for Materials Chemistry Frontiers.

Supporting Information

Self-Oriented TiO_2 Nanosheets in Films for Enhancement of Electron Transport in Nanoporous Semiconductor Network

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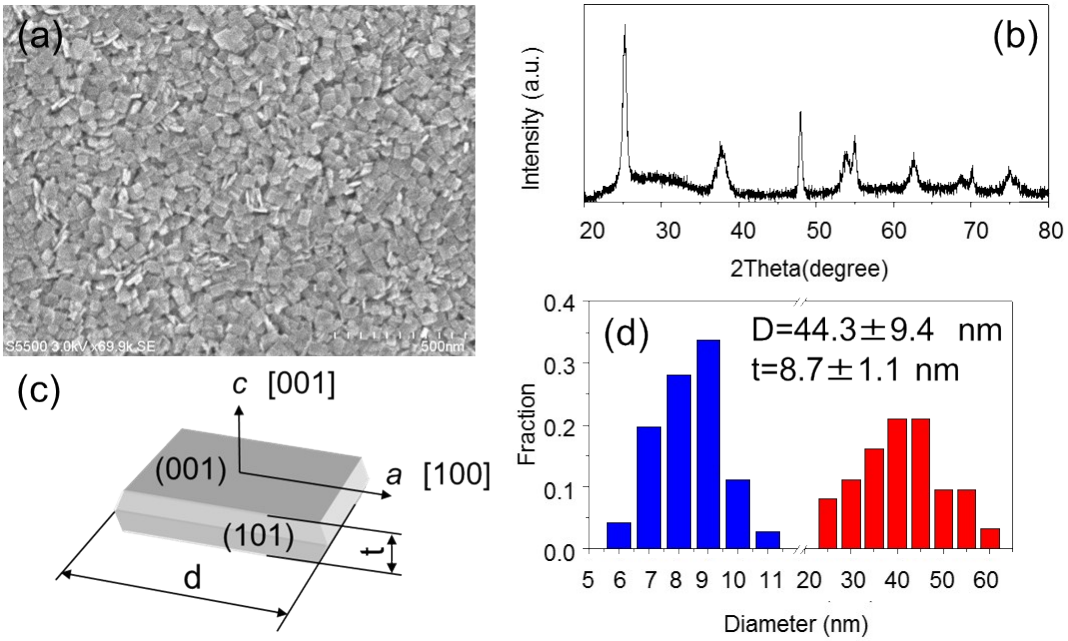


Figure S1 (a) SEM images, (b) powder XRD, (c) schematic anatase nanosheet crystal, and (d) size distributions of as synthesized TiO_2 nanosheets.

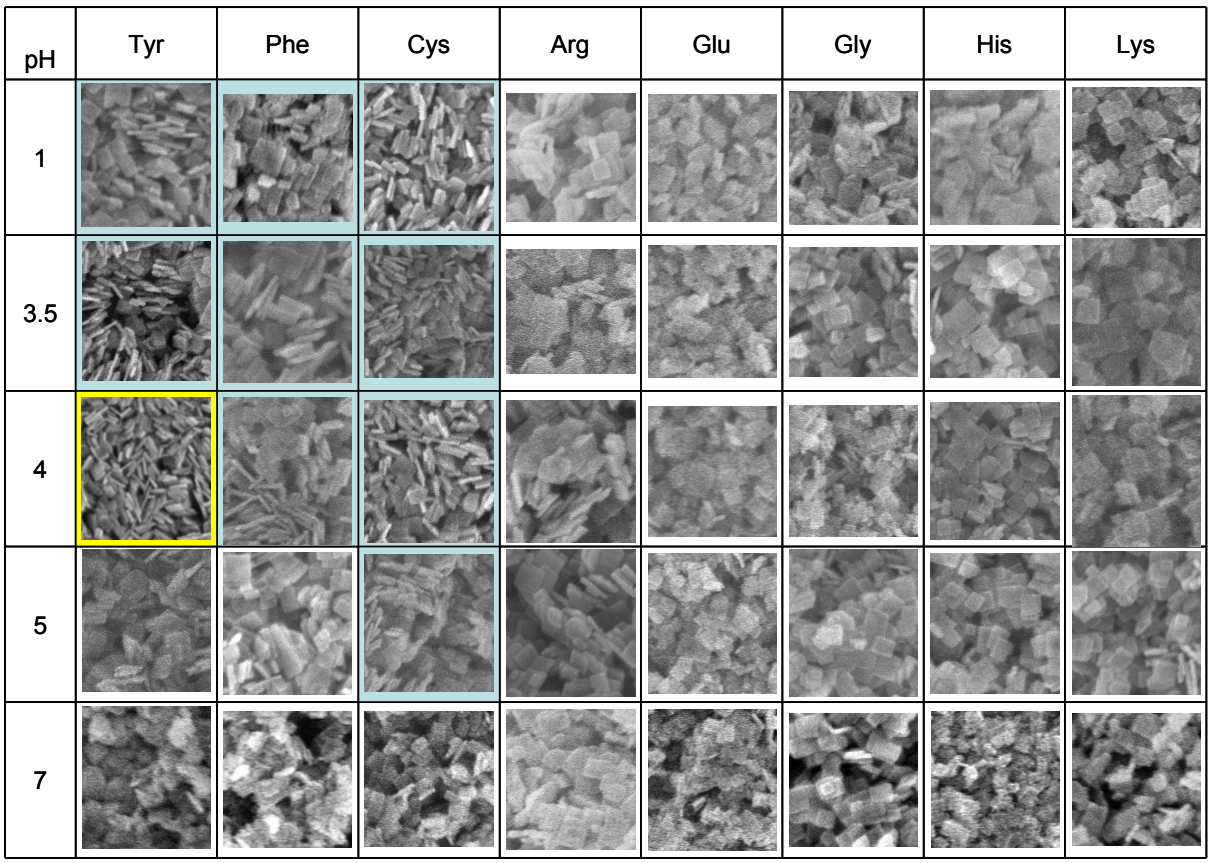


Figure S2 Comprehensive results of SEM images in all assembly conditions.

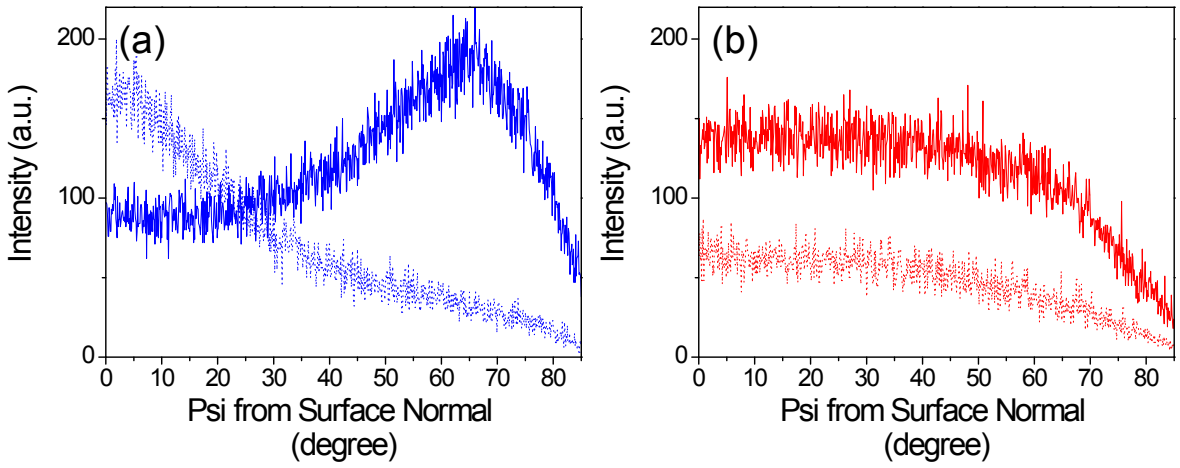


Figure S3-1 Angle resolved XRD out-plane analysis in psi scans of (a) non-functionalized and (b) Tyr-functionalized TiO_2 nanosheets on glass substrate with 2 theta of 25 degree (bold line) and 38 degree (dot line) attributed to anatase TiO_2 (101) and (004) planes, respectively.

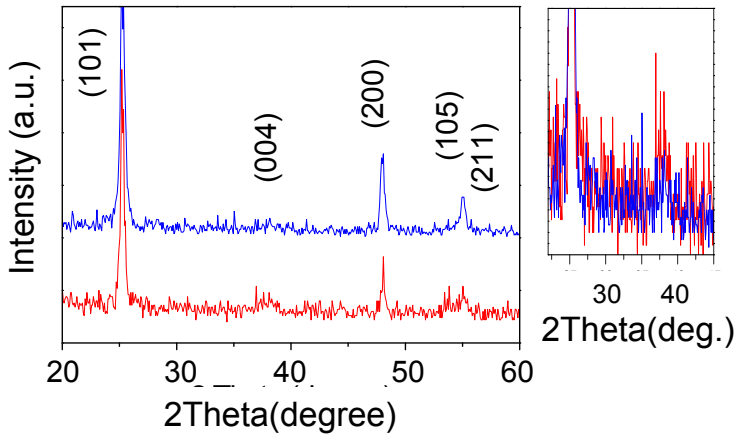


Figure S3-2 X-ray diffraction in-plane analysis with non-functionalized (blue) and Tyr-functionalized (red) TiO_2 indicating the (004) peak. The grazing angle of incident x-ray was 5 degree.

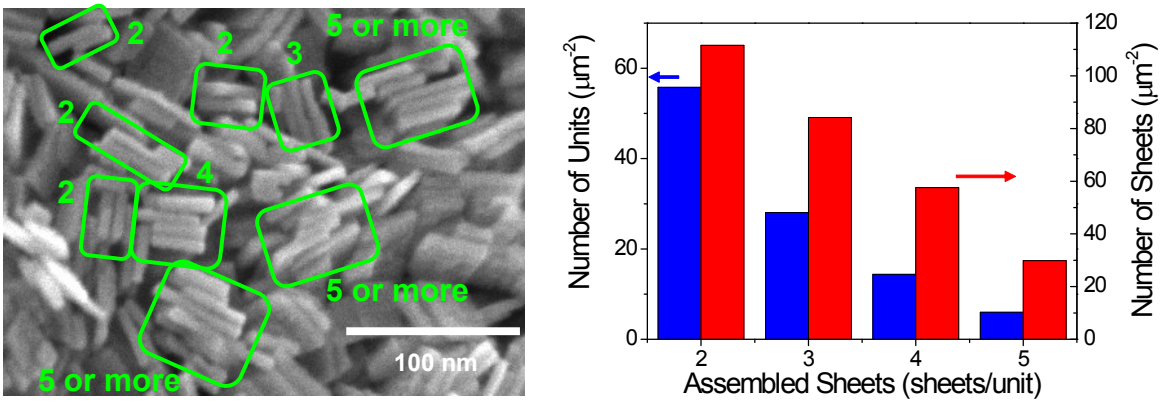
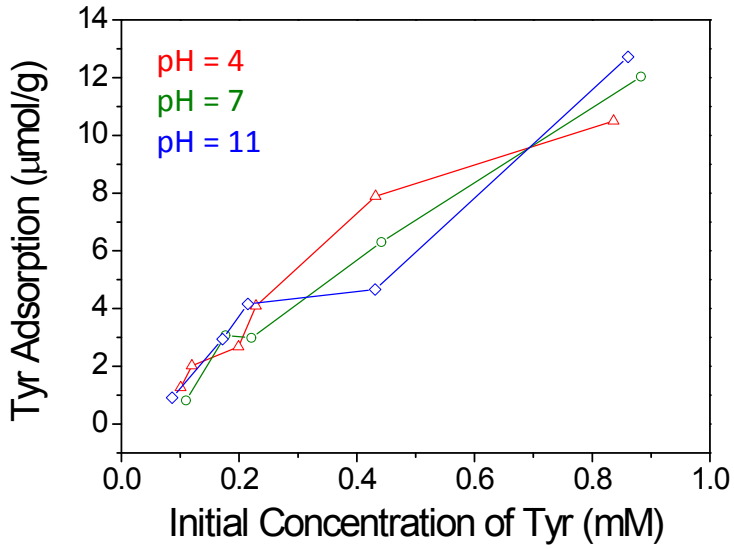
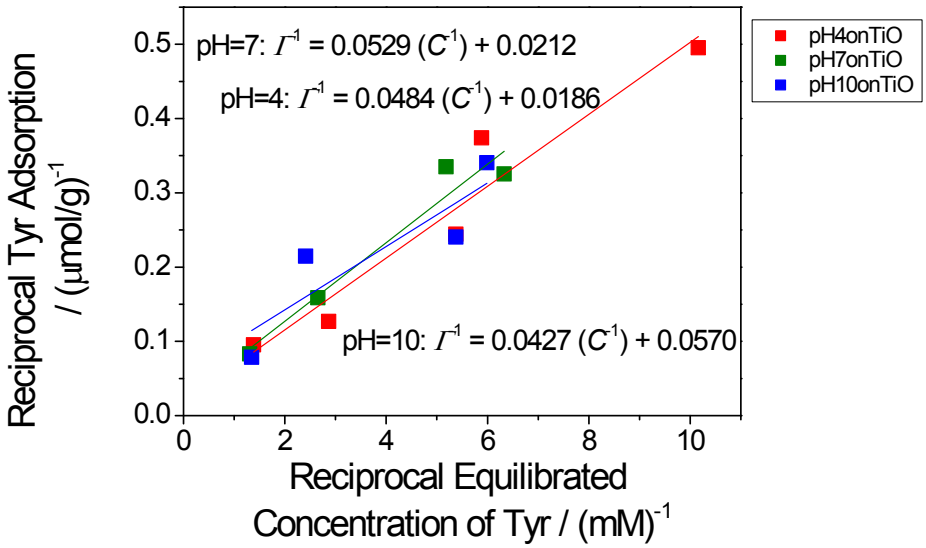


Figure S4 Distribution analysis of nonparallel orientation with stacked nanosheets.



FigureS5-1 Adsorption amount of Tyr on TiO_2 as a function of the concentration of Tyr in aqueous solution estimated by means of the comparison of the absorbance change of Tyr solution (ε=1272 cm^{-1} M^{-1} at 274 nm) measured by UV-vis absorption spectroscopy before and after addition of TiO_2 (10g/L)



FigureS5-2 Adsorption amount of Tyr on TiO_2 analysis based on Lineweaver-Burk equation, $\frac{1}{\Gamma} = \frac{1}{\Gamma_{max}} + \frac{1}{\Gamma_{max} Kc}$.

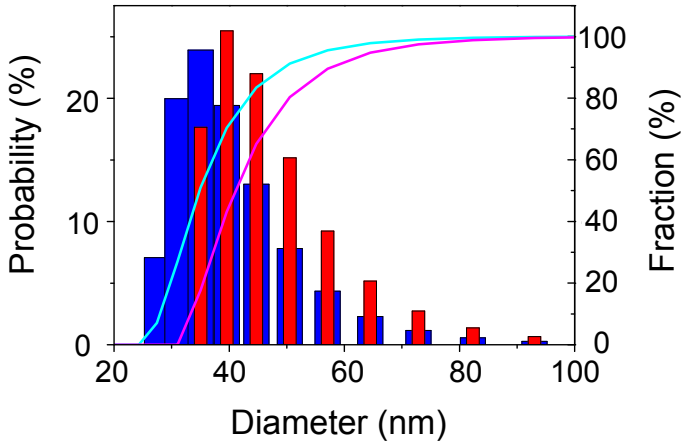


Figure S6 Size distribution of TiO_2 particles suspended in aqueous solution with (red) and without (blue) Tyr in HCl solution (0.01M) at pH4 controlled by an aqueous ammonium hydroxide (0.1M) addition measured by dynamic light scattering method.

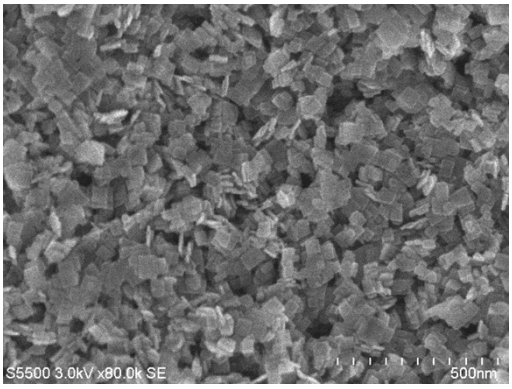


Figure S7 The TiO_2 film on glass prepared with Tyr-functionalized TiO_2 at pH 4 (1mL of TiO_2 suspension (3wt%) and 0.1mL of Tyr (0.5 equivalent molar))with addition of acetone (0.1mL) reducing the oreophobic property of water solvent as the control experiment revealing very little assembly indicating that the hydrophobic inter-particle interaction is one of key factor of self-assembly.

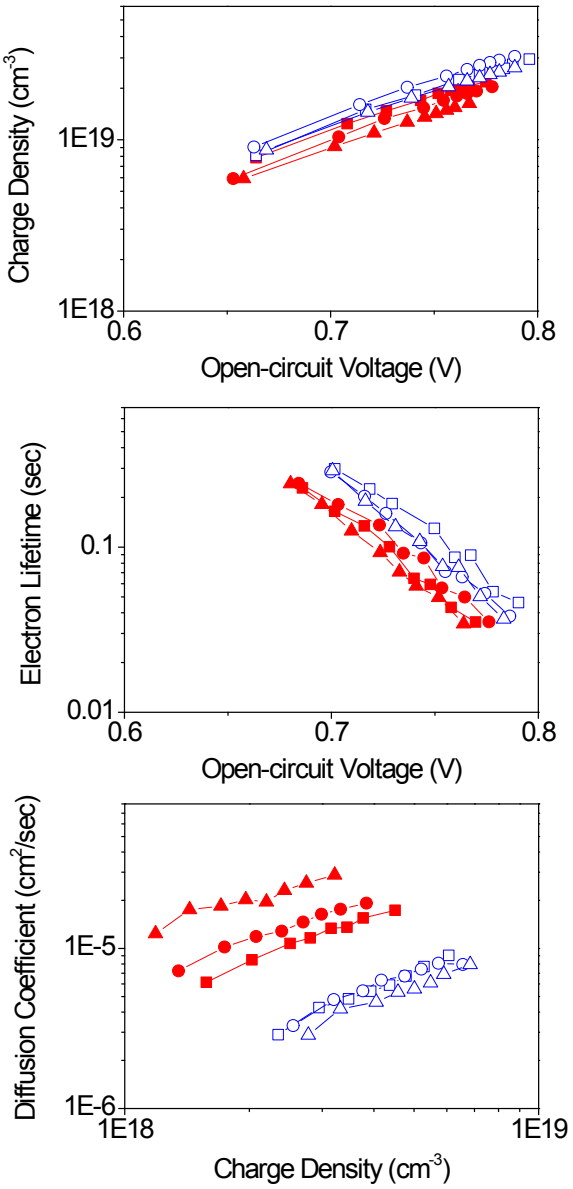


Figure S8 The charge density as the function of open-circuit voltage (top), lifetime of electron as the function of open-circuit voltage (middle), and diffusion coefficient of electron as the function of charge density (bottom) in TiO_2 in DSSC analyzed by means of charge extraction, transient short-circuit photocurrent, and transient open-circuit voltage, respectively, by modulating the incident. TiO_2 porous films are composed of Tyr-functionalized (red), non-functionalized (blue) TiO_2 nanosheets on FTO substrates. Multiple curves indicate the device-to-device deviations, while the representative results are exhibited in Figure 6.

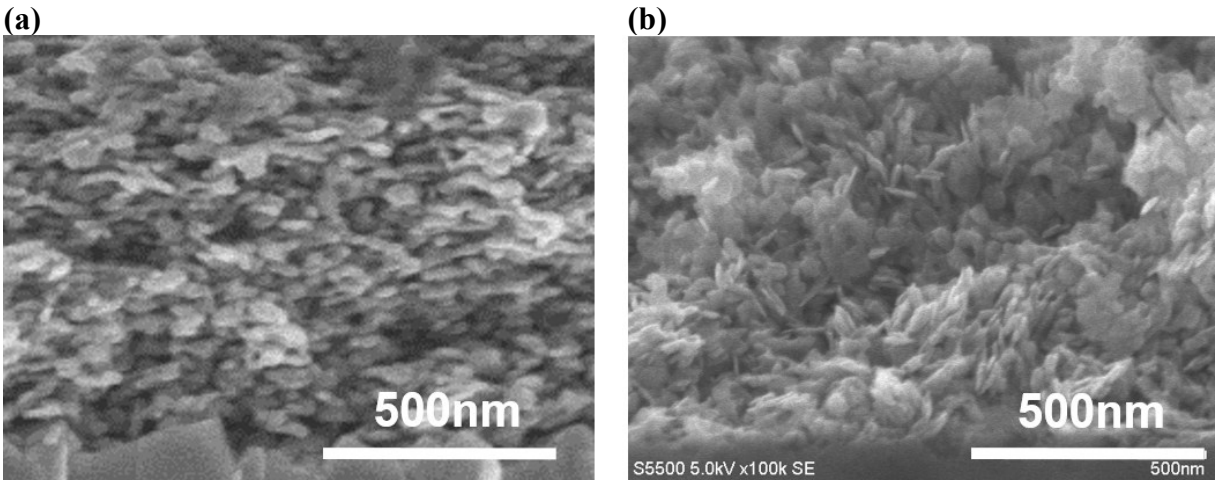


Figure S9 The cross-sectional SEM image of (a) non-functionalized and (b) Tyr-functionalized TiO_2 nanosheets in porous films possessing the thickness of more than a micrometer used for DSSC devices.

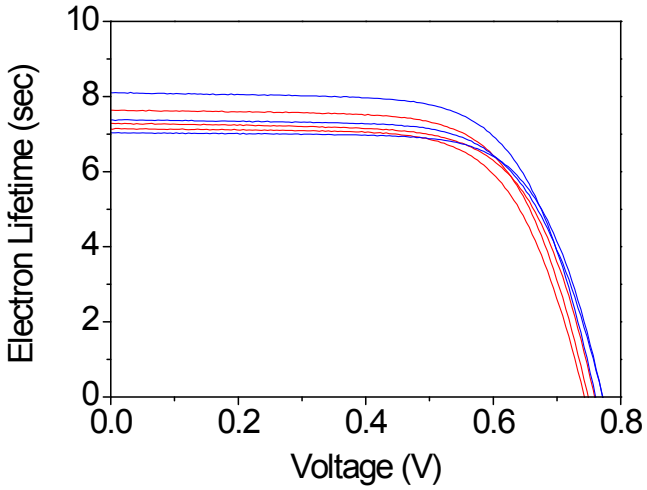


Figure S10 The current-voltage curve of DSSC with TiO_2 porous films composed of Tyr-functionalized (red), non-functionalized (blue) TiO_2 nanosheets on FTO substrates. Multiple curves indicate the device-to-device deviations.

Table S1 The cell performances of DSSC with TiO_2 porous films composed of Tyr-functionalized (Tyr-func.), non-functionalized (Non-func.) TiO_2 nanosheets on FTO substrates.

TiO_2	J_{SC} (mA/cm^2)	V_{OC} (mV)	FF	Efficiency (%)	[a]Dye Loading (μmol/cm^3)	[b]Porosity (%)	[c]BET Surface Area (cm^2/μm·cm^2)
Tyr-func.	7.21±0.35	751±4.0	0.68±0.0	3.71±0.20	99.1	0.51	115
Non-func.	7.21±0.24	772±0.0	0.69±0.02	3.86±0.02	83.9	0.63	108

[a]Measured by UV-vis absorption spectra of solution containing tetrabutylammonium hydroxyde (0.1M) removing the dye-sensitizer from immersed TiO_2 films. [b]Calculated by weighing of TiO_2 films with measured volume with specific weight of pure anatase TiO_2 of 3.9g/cm^3. [c]Brunauer–Emmett–Teller analysis with N_2 adsorption isotherm with scraped TiO_2 films from substrates.