Supporting Information

Float Printing Deposition to Control the Morphology of TiO_2 Photoanodes on Woven Textile Metal Substrate for TCO-free flexible Dye-Sensitized Solar Cell

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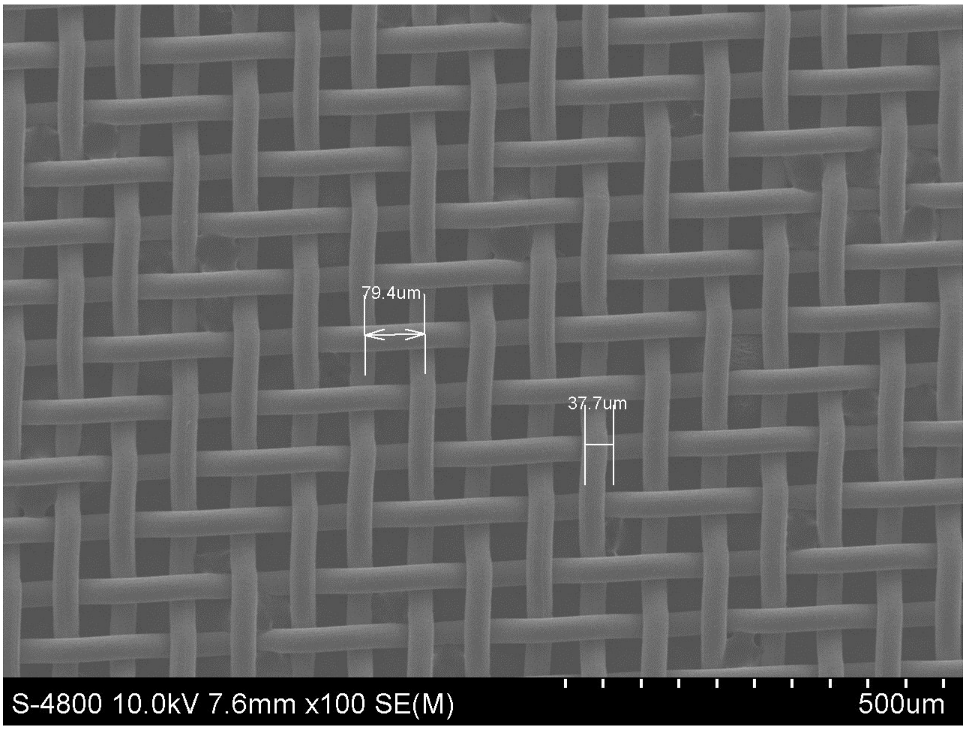

Figure S1. SEM micrograph of Woven SUS wire based textile substrate.

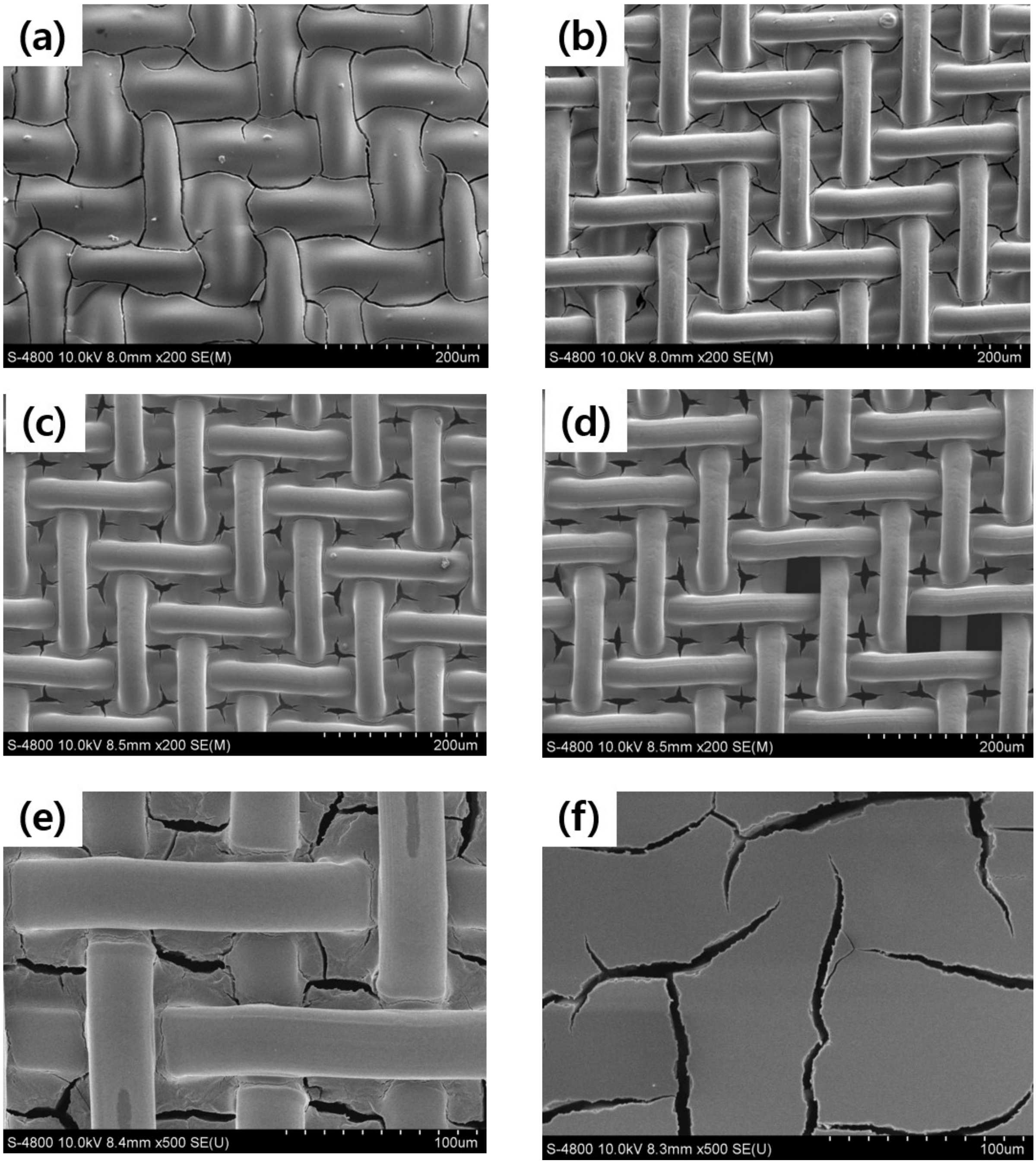

Figure S2. Additional micrographs for electrodes presented in Figure 2. (a) Front side of electrode in Fig. 2(a). (b) Back side of electrode in Fig. 2(a). (c) Front side of electrode in Fig. 2(b). (d) Back side of electrode in Fug. 2(b). (e) Back side of electrode in Fig. 2(c). (f) Front side of electrode in Fig. 2(c).

FEM Analysis Details

We have utilized FEniCS to calculate the electron concentration within the electrode and the current flow. The FEniCS is the general partial differential equation solver based on weak formula and finite element methods (FEM). Therefore, we should derive weak formula from the electron contiguity equation in the electrode. The electron contiguity equation is give as Eq. (S1) as followed:

$$-D\Delta c + k\left(c - c_0\right) - G = 0 \qquad \text{(Eq. S1)}$$

To derive weak formula by variational methods insert test function and integrate through the volume.

$$\int_\Omega \left\{ -\Delta c + \tau\left(c - c_0\right) - \frac{1}{D}G \right\} v\, dx = 0$$

$$\int_\Omega -\Delta c v\, dx + \int_\Omega kcv\, dx = \int_\Omega (kc_0 + G)\, v\, dx \qquad \text{(Eq. S2)}$$

Applying Green identification (Eq. S3) to the Eq. S2, weak formula Eq. S4 is derived.

$$\int_R (\psi\Delta\varphi + \nabla\psi \cdot \nabla\varphi) dV = \oint_{\partial R} \psi\nabla\varphi \cdot dS \quad . \qquad \text{(Eq. S3)}$$

$$\int_\Omega \nabla c \cdot \nabla v\, dx + \int_\Omega \tau c \cdot v\, dx = \int_\Omega (\tau c_0 + \frac{1}{D}G) \cdot v\, dx + \oint_{\partial\Omega} v\nabla c \cdot dS \qquad \text{(Eq. S4)}$$

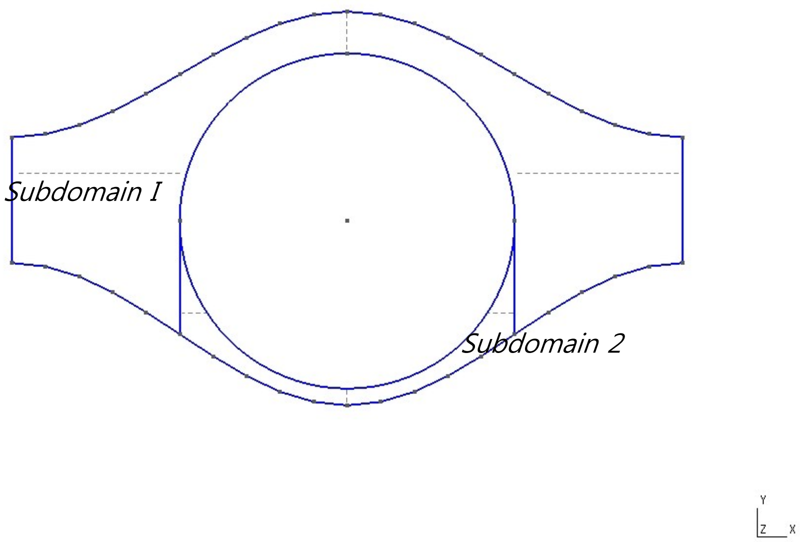

Figure S3. The geometry and subdomains utilized for FEM analysis.

When adjusting test function so that $\oint_{\partial\Omega} v\nabla c \cdot dS$ =0 for Dirichlet boundary condition, final weak formula was derived as Eq. S5.

$$\int_{\Omega} \nabla c \cdot \nabla v \, dx + \int_{\Omega} \tau c \cdot v \, dx = \int_{\Omega} \left(\tau c_0 + \frac{1}{D}G\right) \cdot v \, dx + \oint_{\partial\Omega_N} v\nabla c \cdot dS \qquad \text{(Eq. S5)}$$

In this calculation Dirichlet boundary conditions were applied as $c=c_0$ at the interface of metal wire and electrode and Neumann boundary conditions were applied as $\oint_{\partial\Omega_N} \nabla c \cdot dS = 0$ for outer surface of electrodes. The both sides of electrode were set as periodic boundaries.

For the photon distribution within the electrode, the electrodes are divided into two sub-domains as shown in Fig. S3. In Subdomain I, the photons are distributed by Beer-Lambert Law according to Eq. S6

$$G = aI_0 exp\{-a(y_{front} - y)\} \qquad \text{(Eq. S6)}$$

However, in Subdomain II, the photons are not illuminated by shading of metal wire.

The mesh and geometry was created by Gmsh code. The FEM elements are triangular Lagrange type elements and at least 3000 elements were used for calculation for example as shown in Fig. S4.

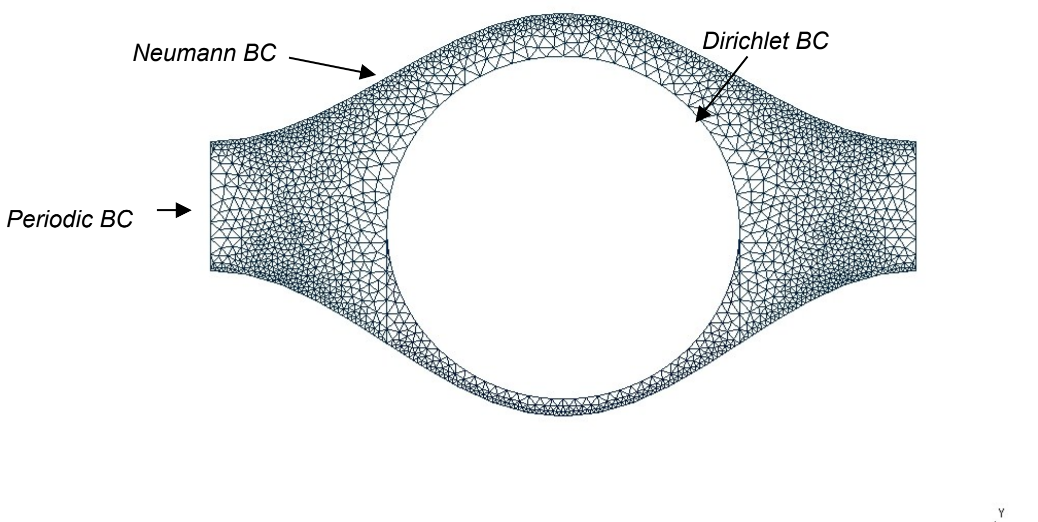

Figure S4. Elements and setting boundary conditions for FEM analysis.

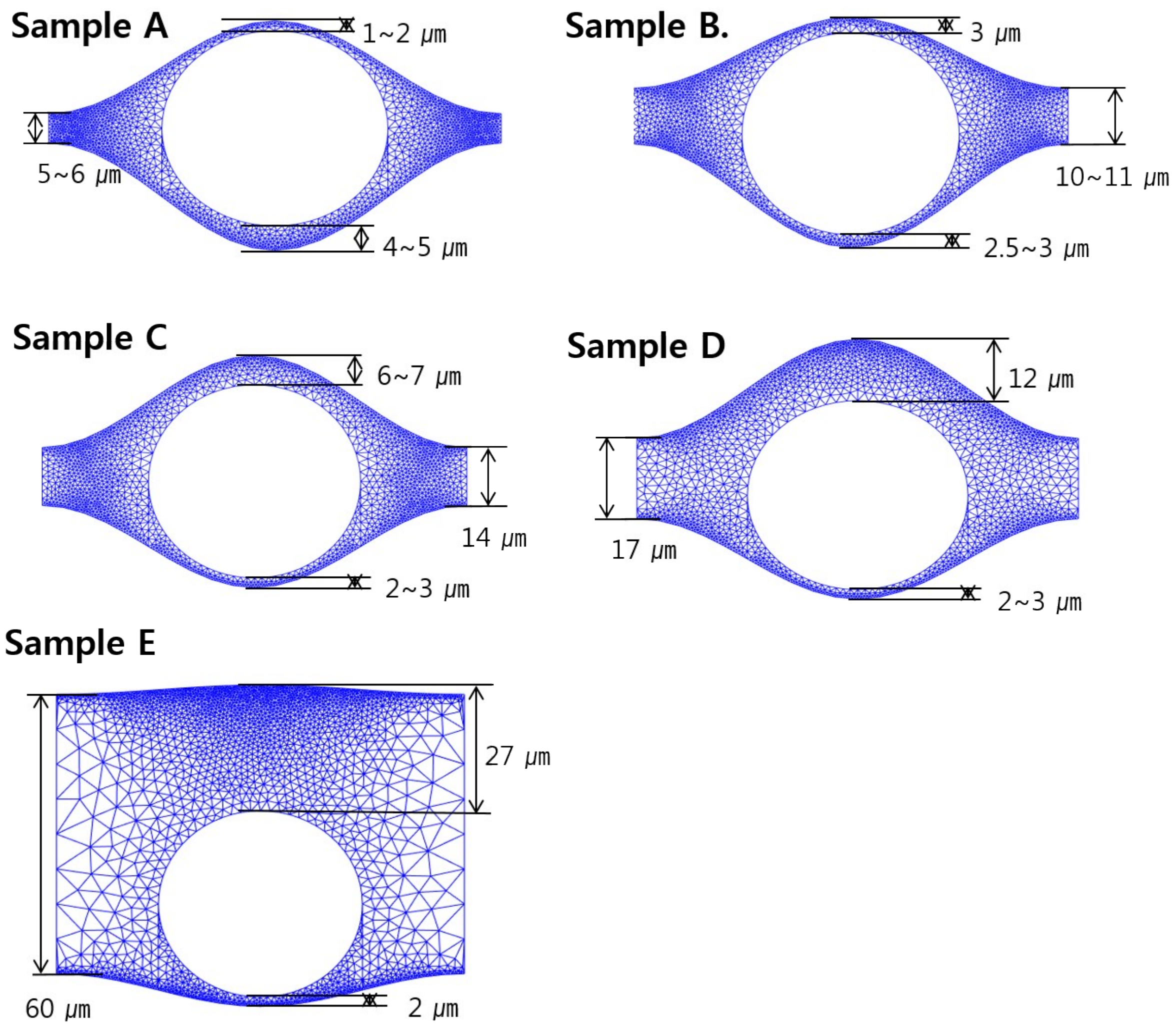

Figure S5. The geometry and mesh generated for the calculation of samples listed in Table 1.

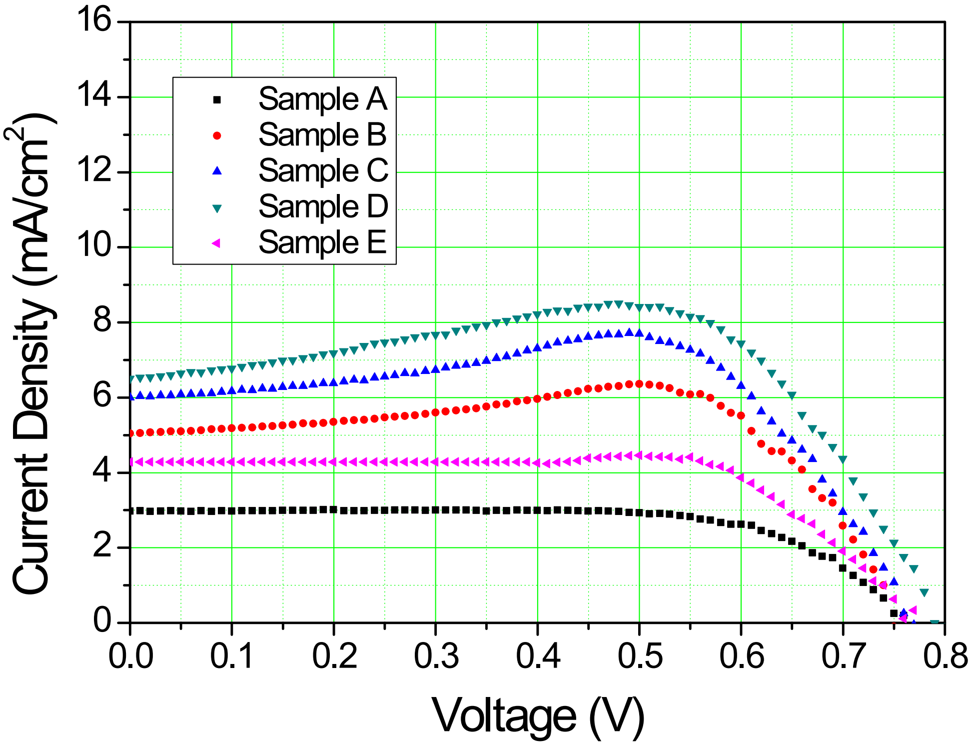

Figure S6. Representative relationship between current density and voltage under 1sun, 1.5AM of samples listed in Table 1.

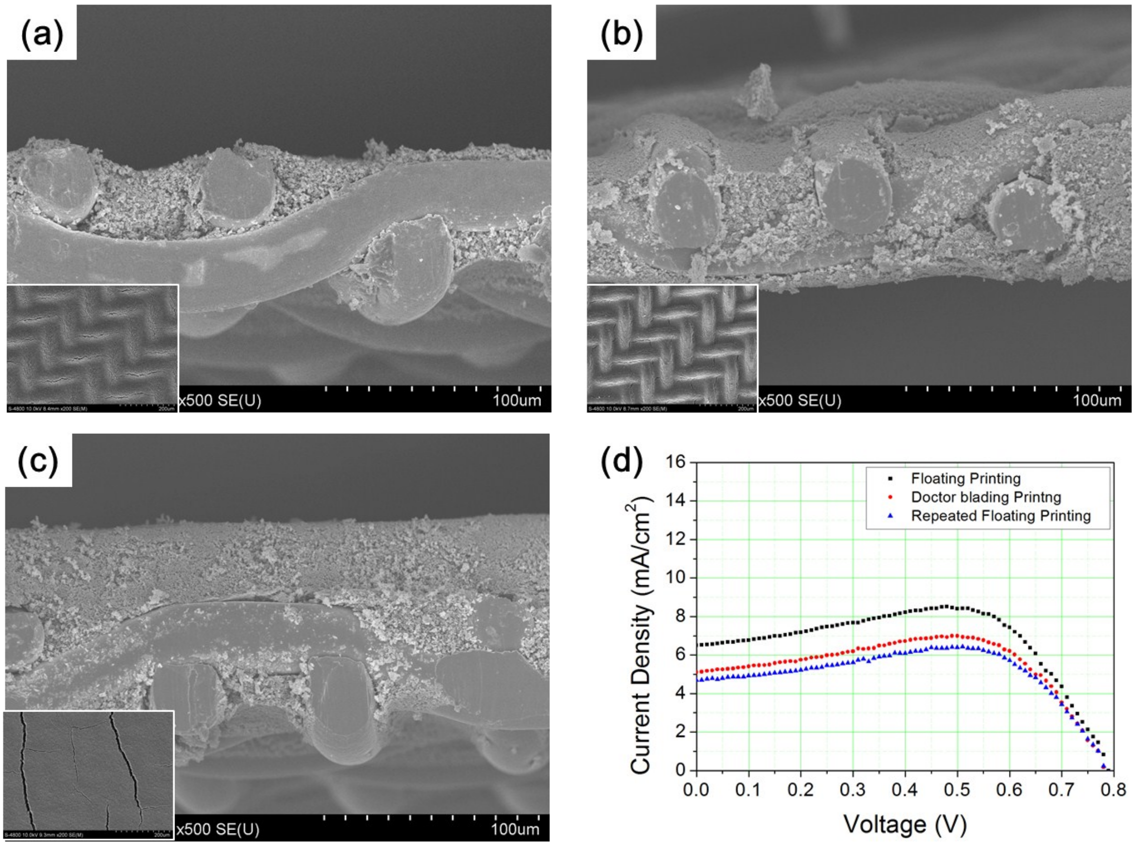

Figure S7. Scanning electron micrograph of Pt decorated carbon pasted deposited on textile substrate with (a) single floating printing method (left lower inset image shows front side view), (b) doctor blading process (left lower inset image shows front side view) and (c) repeated floating printing method (left lower inset image shows front side view). (d) Relationship between current density and voltage under 1sun, 1.5AM depends on counter electrode's deposition method.

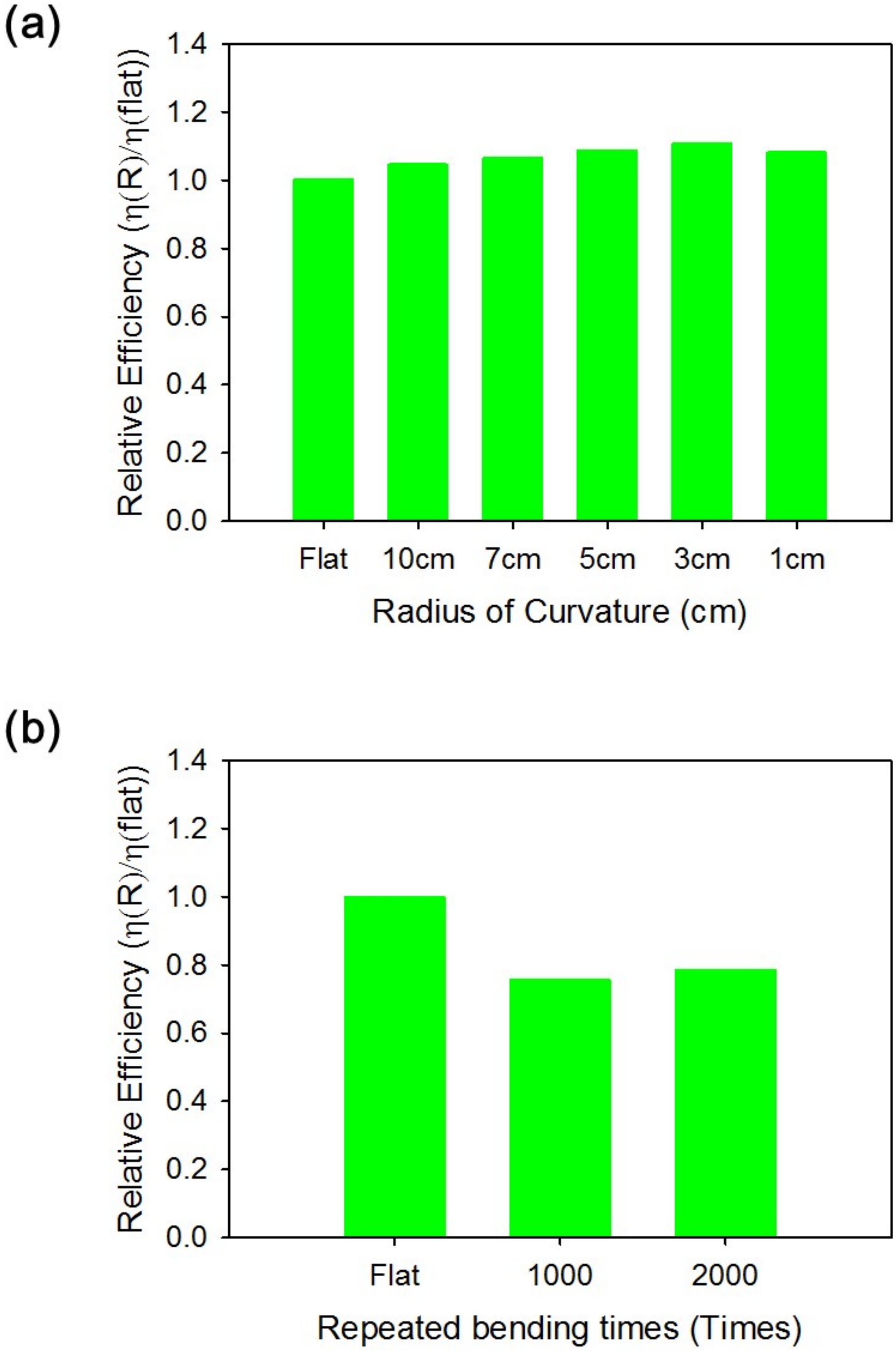

Figure S8. The relative energy conversion efficiency to flat state of flexible DSSC cells according to (a) bending radius of curvature and (b) be repeated bending.