Supplementary Information

Dual Functionalized Freestanding TiO_2 Nanotube Arrays Coated with Ag Nanoparticles and Carbon Materials for Dye-Sensitized Solar Cells

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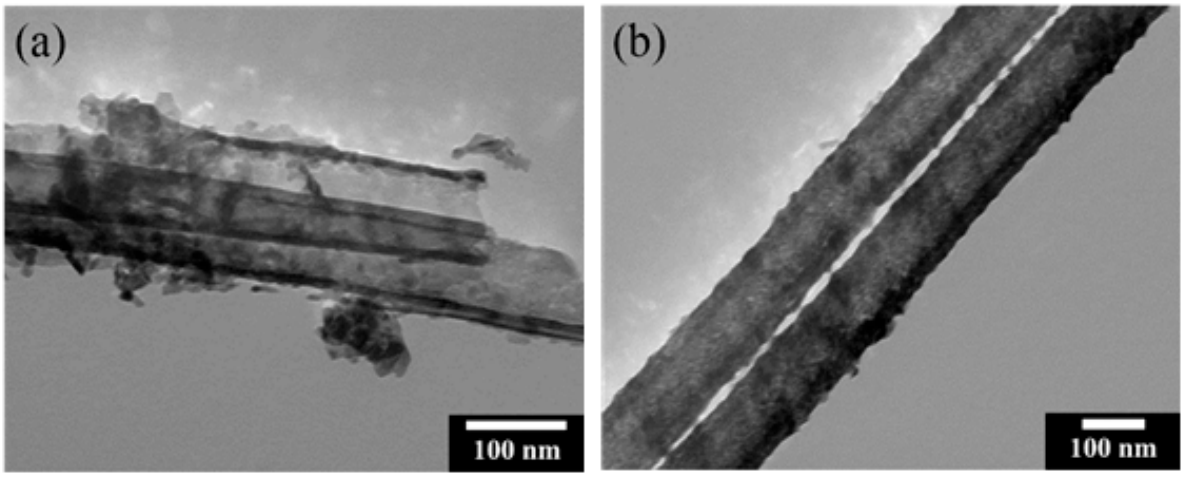

Figure S1. TEM images of TiO_2 nanotube arrays (a) without and (b) with carbon materials.

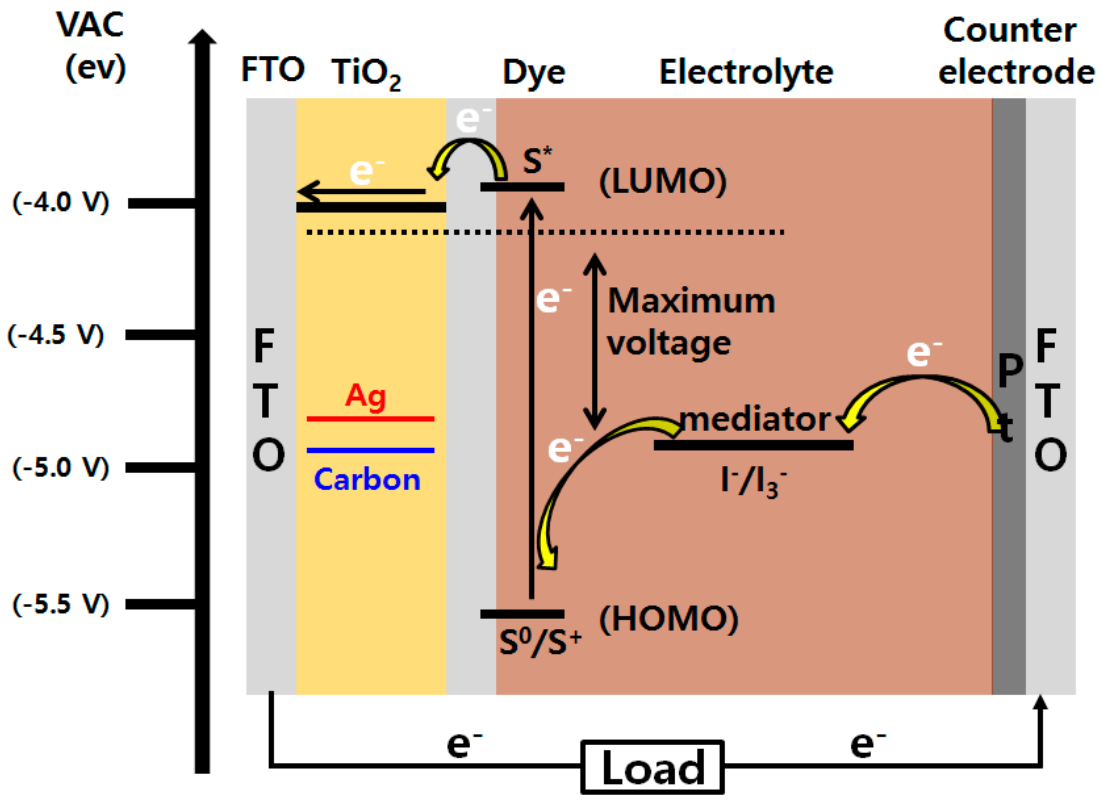

Figure S2. Energy band diagram of DSSCs.

When carbon materials and Ag NPs were introduced on the TiO_2 nanotube arrays, the conduction band of the TiO_2 nanotube arrays was shifted to a lower energy level, since the work functions of the other two materials were both lower (−4.9 eV and −4.3 eV, respectively) as shown in Figure S2. Especially, when Ag NPs were introduced on the TiO_2 nanotube arrays, more electrons were collected on the Ag NPs to reduce the V_{oc} and *ff*. However, due to the TiO_2 layer coated on the Ag NP surface, the electron density of the TiO_2 nanotube arrays was also increased due to the "charging effect". Therefore, coating Ag NPs or carbon materials on the nanotube arrays did not affect the values of V_{oc} and *ff* of the associated DSSCs significantly.

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Table S1. Parameters determined by EIS[a].

DSSCs based on open-ended TiO_2 NTAs decorated	R_w (Ω)	R_w / R_k	κ_{eff} [s^{-1}]	τ [ms]	D_{eff} [cm^2/s]	L_n [mm]
without Ag NPs and carbon materials	52.5	3.23	50.1	19.9	64.7 x 10^{-5}	35.9
with Ag NPs	40.5	3.37	33.8	29.6	45.6 x 10^{-5}	36.7
with carbon materials	40.6	3.38	35.1	28.5	47.4 x 10^{-5}	36.7
with Ag NPs and car bon materials	31.6	3.40	25.1	39.8	34.1 x 10^{-5}	36.8

[a] EIS was measured with 20 μm-thick photoanode, composed with TiO_2 nanotube arrays and nanoparticles under 100mW/cm^2 lamp.

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