Electronic Supplementary Material (ESI) for Energy & Environmental Science
This journal is © The Royal Society of Chemistry 2013

# Supplementary Information

# Gold Nanoparticles Inlaid $TiO_2$ Photoanodes: A Superior Candidate for High-Efficiency Dye-Sensitized Solar Cells

*Yan Li,*[†,‡] *Hong Wang,*[†,⊥] *Quanyou Feng,*[†,⊥] *Gang Zhou,*[†] *and Zhong-Sheng Wang**[,†]

[†] Department of Chemistry, Lab of Advanced Materials, Fudan University, Shanghai 200438, P. R. China

[‡] Present address: Key Laboratory of Atomic and Molecular Physics & Functional Materials of Gansu Province, College of Physics and Electronic Engineering, Northwest Normal University, Lanzhou 730070, P. R. China

* E-mail: zs.wang@fudan.edu.cn

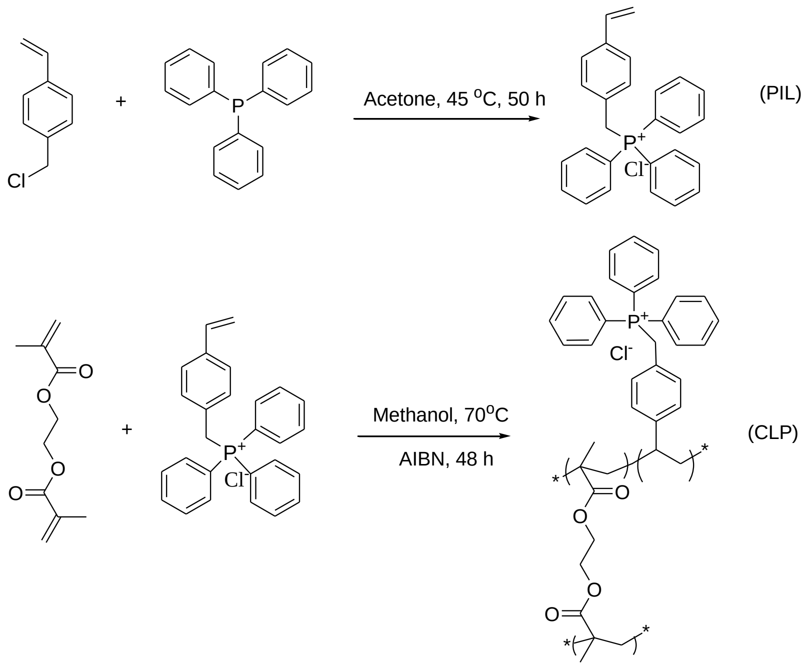


***Figure S1***. Synthetic route of the cross-linked polymer (CLP).

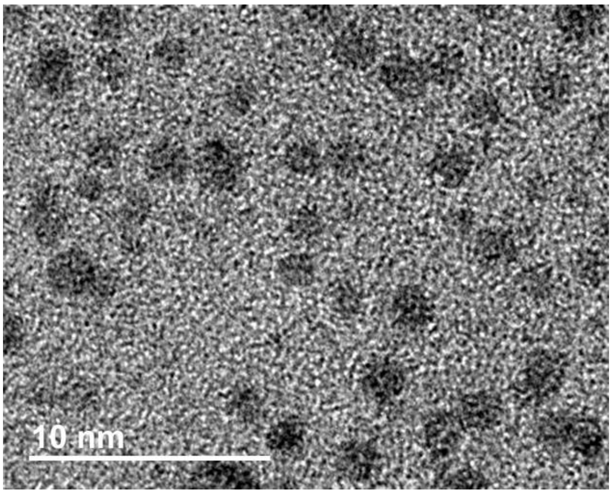


***Figure S2***. TEM image of the as-synthesized polymer stabilized Au nanoparticles dispersed in methanol.

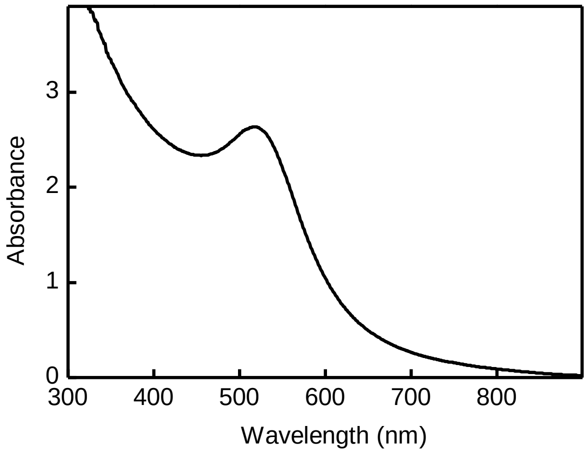


***Figure S3***. UV-vis absorption spectrum of the as-synthesized polymer stabilized Au nanoparticles dispersed in methanol.

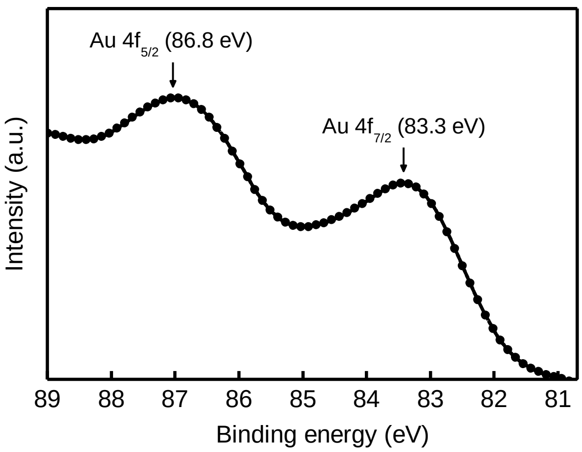


***Figure S4.*** XPS spectrum of the Au-$TiO_2$ (Au/$TiO_2$ = 0.800wt%) composite film.

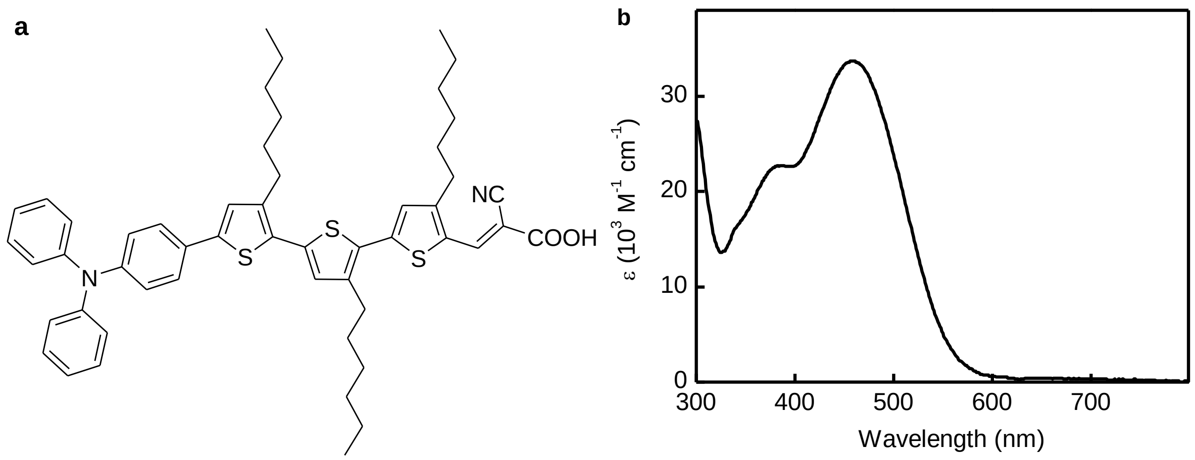


***Figure S5.*** (a) The chemical structure of **FNE29** and (b) the UV-vis absorption spectrum of **FNE29** in THF.

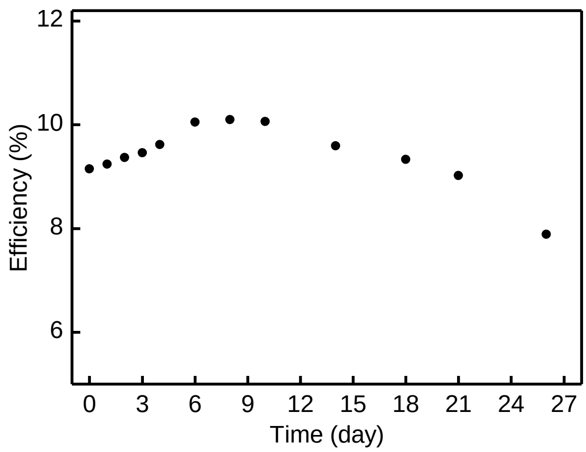


***Figure S6.*** Efficiency evolution of the best DSSC fabricated with 0.168 wt% Au-$TiO_2$ photoanode subjected to aging.

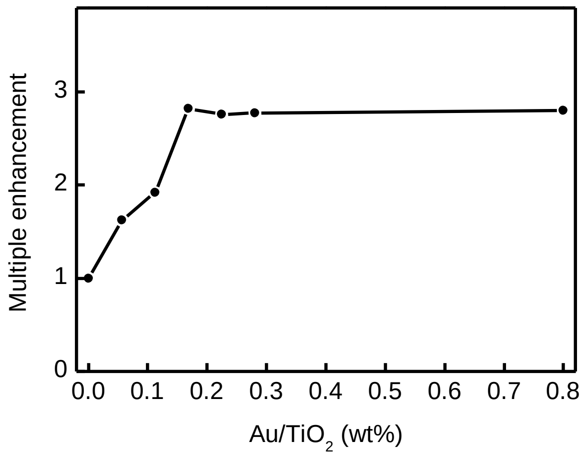


***Figure S7.*** The multiples in enhancement of maximum absorbance of **FNE29** caused by the plasma effect as a function of Au amount. Assuming that the absorbance of dye-loaded $TiO_2$ film is proportional to the dye amount without regard to the plasma effect, this suppositional absorbance ($A$'(Au-$TiO_2$)) for each dye-loaded Au-$TiO_2$ film is estimated from the absorbance of dye-loaded pure $TiO_2$ film ($A$($TiO_2$) times the dye amount in each film ($c$(Au-$TiO_2$)) divided by the dye amount in pure $TiO_2$ film ($c$($TiO_2$)). Therefore, multiple enhancement = $A$(Au-$TiO_2$)/$A$'(Au-$TiO_2$), where $A$(Au-$TiO_2$) is the measured absorbance for the dye-loaded Au-$TiO_2$ film.

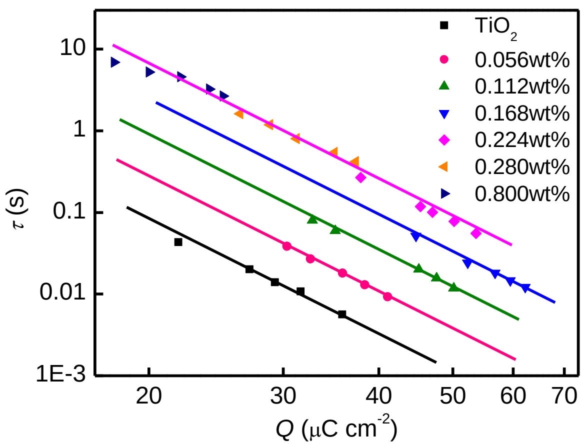


***Figure S8.*** Electron lifetime as a function of charge density at open circuit.

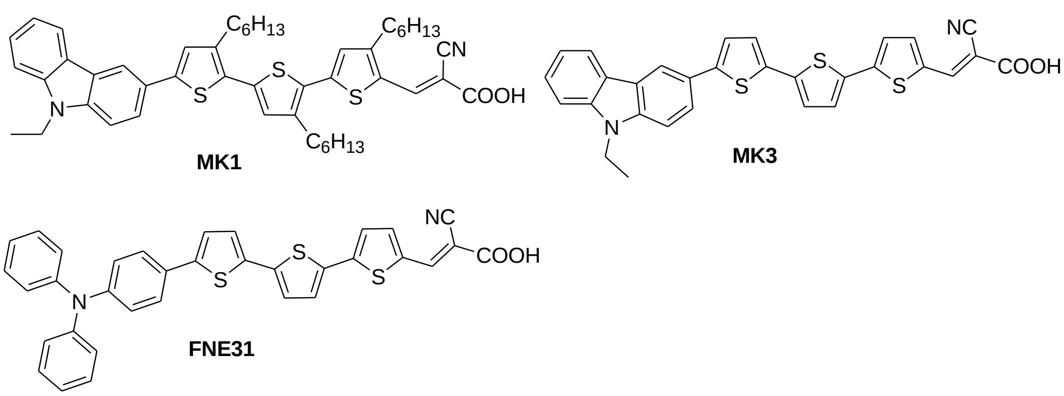


***Figure S9.*** Structures of dyes **MK1** (ref. 1), **MK3** (ref.1) and **FNE31** (ref.2).

***Table S1.*** Photovoltaic performance parameters for DSSCs based on various dyes and 4 μm films[a].

| Dye | Photoanode | $V_{oc}$ (mV) | $J_{sc}$ (mA cm$^{-2}$) | FF | η (%) |
|---|---|---|---|---|---|
| **MK1** | $TiO_2$ | 782 | 7.53 | 0.64 | 3.77 |
| | Au-$TiO_2$ | 815 | 10.21 | 0.68 | 5.66 |
| **MK3** | $TiO_2$ | 713 | 7.90 | 0.75 | 4.22 |
| | Au-$TiO_2$ | 749 | 11.95 | 0.76 | 6.80 |
| **FNE31** | $TiO_2$ | 746 | 6.11 | 0.75 | 3.42 |
| | Au-$TiO_2$ | 774 | 8.73 | 0.76 | 5.14 |

[a] The Au/$TiO_2$ weight ratio in the Au-$TiO_2$ film is 0.104wt%.

**References**

1. Wang, Z.-S.; Koumura, N.; Cui, Y.; Takahashi, M.; Sekiguchi, H.; Mori, A.; Kubo, T.; Furube, A.; Hara, K. *Chem. Mater*. **2008**, *20*, 3993.
2. Tomas, K. R. J.; Hsu, Y.-C.; Lin, J. T.; Lee, K.-M.; Ho, K.-C.; Lai, C.-H.; Cheng, Y.-M.; Chou, P.-T. *Chem. Mater*. **2008**, *20*, 1830.