Electronic Supplementary information (ESI) *for*

Plasmonic Cooperation Effect of Metal Nanomaterials at Au-TiO_2-Ag Interface to Enhance Photovoltaic Performance for Dye Sensitized Solar Cells

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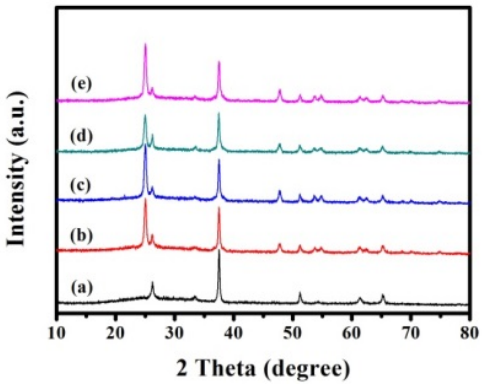

Figure S1. X-ray diffraction (XRD) of FTO glass (a), FTO/TiO_2 film (b), FTO/TiO_2/Au film (c), FTO/TiO_2/Ag film (d) and FTO/Au/TiO_2/Ag film (e) without N719 dye.

TiO_2 / (Au, Ag or Au and Ag) films were characterized by XRD analyses to judge the presence of metal nanoparticles. Fig. S1 showed the XRD patterns of FTO glass (a), FTO/TiO_2 film (b), FTO/TiO_2/Au film (c), FTO/TiO_2/Ag film (d) and FTO/Au/TiO_2/Ag film (e). Comparing with the XRD curves of films, all films showed anatase phases belonged to TiO_2. However, it could not detect the diffraction of Au and Ag species. The result might be caused by the low amount of Au or Ag anchored on TiO_2 films.

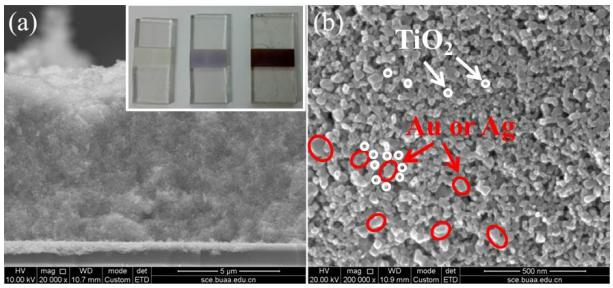

Figure S2. (a) Cross section image of Au-TiO_2-Ag electrode (inset the electrodes image, from left to right: TiO_2 (white), Au-TiO_2 (purple) and Au-TiO_2-Ag (brown)); (b) SEM enlargement image of Au-TiO_2-Ag electrode.

The image of the electrodes is shown in inset figure S2a (from left to right: TiO_2 (white), Au-TiO_2(purple) and Au-TiO_2-Ag (brown)). Figure S2a is the SEM cross section view of Au-TiO_2-Ag electrode. The thickness of Au-TiO_2-Ag electrode is ~10 um. Figure S2b is the SEM enlargement image of Au-TiO_2-Ag electrode. White ring represents the TiO_2. Red ring represents the Au or Ag nanomaterials. We differentiate the difference between TiO_2 and metal nanomaterials through the size of nanoparticles. The diameter of TiO_2 is ~20 nm (TiO_2 was characterized by XRD analyses, as shown in figure S1). The diameter of Au or Ag is ~60 nm (the presence of Au and Ag was judged by XPS, as shown in figure 3). Each of Au or Ag nanomaterials is surrounded by TiO_2. Therefore, the Au-TiO_2-Ag interface is existed.

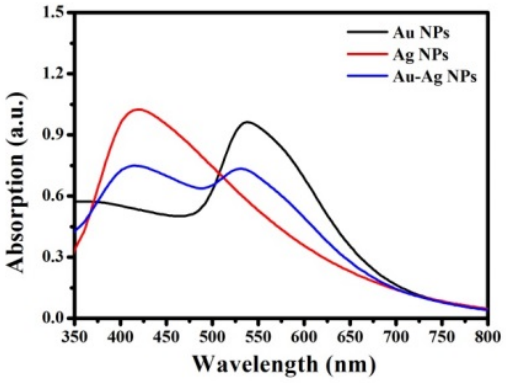

Figure S3. UV-vis absorption of Au nanoparticles, Ag nanoparticles and Au-Ag nanoparticles.

Plasmonic cooperation effect of Au and Ag were characterized by UV-vis absorption. Figure S2 showed the UV-vis absorption spectra of Au nanoparticles (black), Ag nanoparticles (red) and Au-Ag nanoparticles (blue). The position of Au nanoparticles and Ag nanoparticles absorption peak were 538 nm and 415 nm, respectively. When Au and Ag nanoparticles were mixed, the broadening phenomenon centered in 475 nm was happened, which was caused by plasmonic cooperation effect of Au and Ag.