

## Supporting Information

### **Preparation of Ag decorated Fe<sub>2</sub>O<sub>3</sub>/SnO<sub>2</sub> composite nanofibers**

15 ml deionized water and isometric ethanol were mixed by adding 0.3 g Triton-X 100 under vigorous stirring for 30 min. Then 1/500 M AgNO<sub>3</sub> were added into the above solution and kept on stirring for 30 min in dark. Subsequently, 10 mg Fe<sub>2</sub>O<sub>3</sub>/SnO<sub>2</sub> composite nanofibers were mixed into the solution. After stirring for another 30 min, the mixture was irradiated under 300W UV lamp for 5 min and the Ag nanoparticles were formed on the surface of the nanofibers.

### **Preparation of TiO<sub>2</sub>/Au/PPy core-shell nanofibers**

In a typical procedure, 1.5 g of tetrabutyl titanate and 0.09 g HAuCl<sub>4</sub>·6H<sub>2</sub>O were mixed with 3 mL of acetic and 3 mL of ethanol in glovebox under vigorous stirring for 10 min. Subsequently, this solution was added to 7.5 mL of ethanol containing 0.45 g of poly (vinyl pyrrolidone) (PVP). Finally, the as-prepared gel was loaded into a syringe and connected to a high-voltage power supply for electrospinning. An electric potential of 10 kV was applied between the orifice and the ground at a distance of 15 cm. Then, calcination (500°C in air for 5 h) was used to treat the as-spun composite nanofibers to prepare TiO<sub>2</sub>/Au nanofibers.

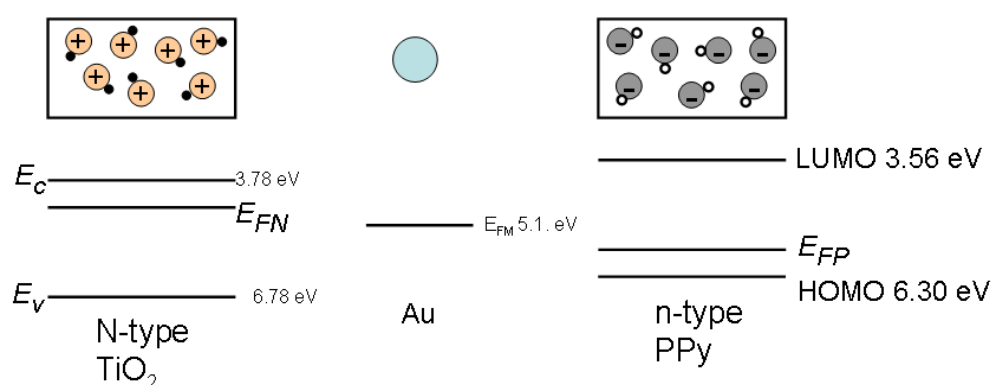
0.025 g of the TiO<sub>2</sub>/Au nanofibers was dispersed into 50 ml of distilled water solution containing 0.005 g of SDS. It was ultrasonicated for 5 min and then followed by vigorous stirring for about 2 h at room temperature. After the solution was put into a refrigerator for 5 min, 0.075 g of pyrrole was added into the above solution. Then 5 ml FeCl<sub>3</sub>·6H<sub>2</sub>O aqueous solution was added to the above solution for the polymerization. The reaction was carried out by ultrasonication for about 10 min and then kept stirring for 2 h. The resulting precipitate was filtered and washed with water and ethanol for several times. Finally, the precipitated was dried in vacuum at 50°C for 12 h.

## Preparation of TiO<sub>2</sub>/PPy core-shell nanofibers

The preparation procedure for TiO<sub>2</sub>/PPy core-shell nanofibers was similar to that of TiO<sub>2</sub>/Au/PPy nanofibers. First, we prepared TiO<sub>2</sub> nanofibers and the progress was the same as preparing TiO<sub>2</sub>/Au nanofibers without adding HAuCl<sub>4</sub>.6H<sub>2</sub>O. Subsequently we used solution-phase polymerization to coat PPy shell as above.

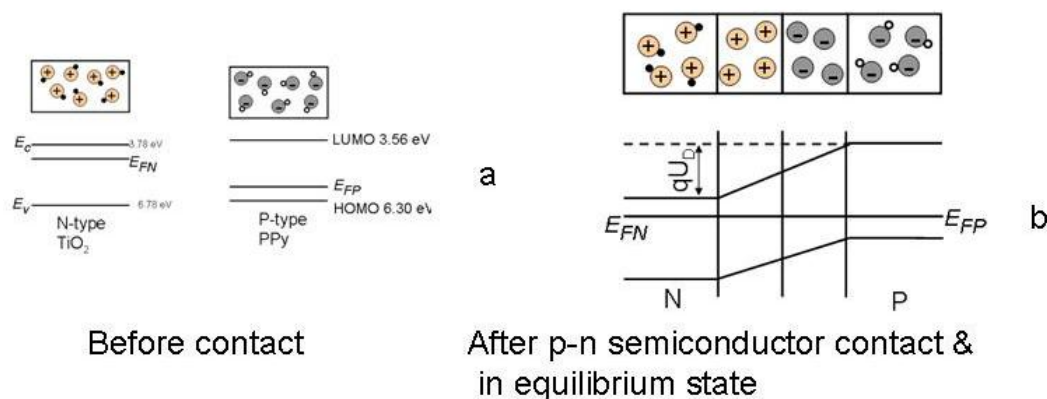
### The mechanism of action by metal nanoparticles induced into the p-n junction.

Metal (Ag or Au) nanoparticles existing in the interface can accelerate the electron transition from n-type semiconductors to p-type semiconductors for its modest work function between the  $E_{FN}$  and  $E_{FP}$  as shown in Scheme S1.



**Scheme S1.** Schematic diagram of Fermi energy level of n-type semiconductor (TiO<sub>2</sub> was used as model here), metal nanoparticles (Au was used as model here), and p-type semiconductors (PPy was used as model here).

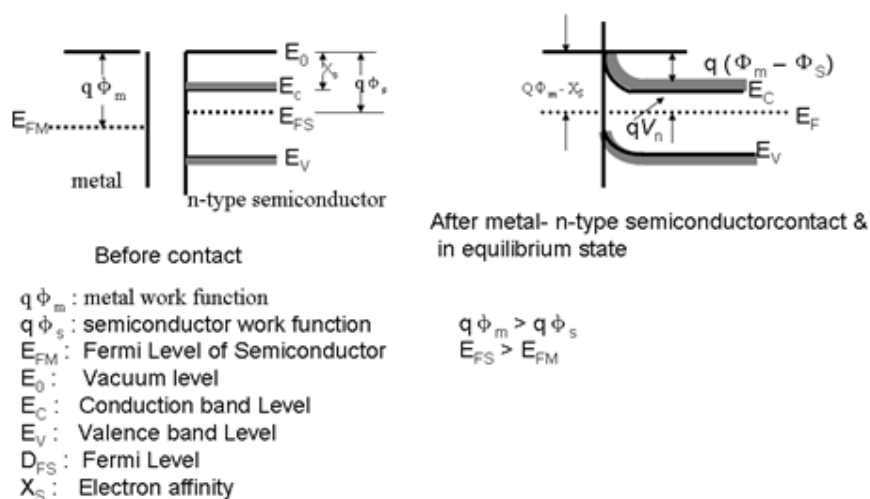
For the typical p-n junction in equilibrium state, the Fermi Level is at the same level as shown in Scheme S2 below.



**Scheme S2.** Schematic diagram of p-n junction in equilibrium state.

Once metal nanoparticles have been induced into the p-n junction, the electron transfer between n-type semiconductor and p-type semiconductors can be accelerated.

(1) It's well known that when metal contact with semiconductor, **Shottky Barrier** ( $q\Phi_b = q(\Phi_m - X_s)$ ) forms. For the electrons within the n-type semiconductor (NTS) occupy higher energy level than those within metal, thus, electrons within the NTS will cross over to the metal and make the two Fermi Level at the same level. The final  $E_F$  is between the  $E_{FM}$  and  $E_{FS}$ , which means that the Femi Level of the n-type  $TiO_2$  has been lowered as shown in Scheme S3.



**Scheme S3.** Schematic diagram of Femi Level of the metal/n-type semiconductor.

The voltage barrier between the p-type PPy ( $E_{FP}$  as shown in Scheme 1 above) and metal/n-type  $TiO_2$  ( $E_F$  as shown in Scheme 3) has been further lowered. Thus, the charges transfer becomes easier, which makes the space charge region (Region B) within the PPy shell become wider. At this time, if the whole thickness of the PPy shell is less or equal to region B (as mentioned in Scheme 3 in the manuscript), the concentration of the residual holes within Region B will be further reduced, resulting in the smaller response (as proven in Fig. 10a). If the whole thickness of the PPy shell is thicker than region B, the interfacial metal nanoparticles can makes the Region B thicker, namely, the thickness of Region A become thinner. Thus, larger response can be obtained (as proven in Fig. 10b).

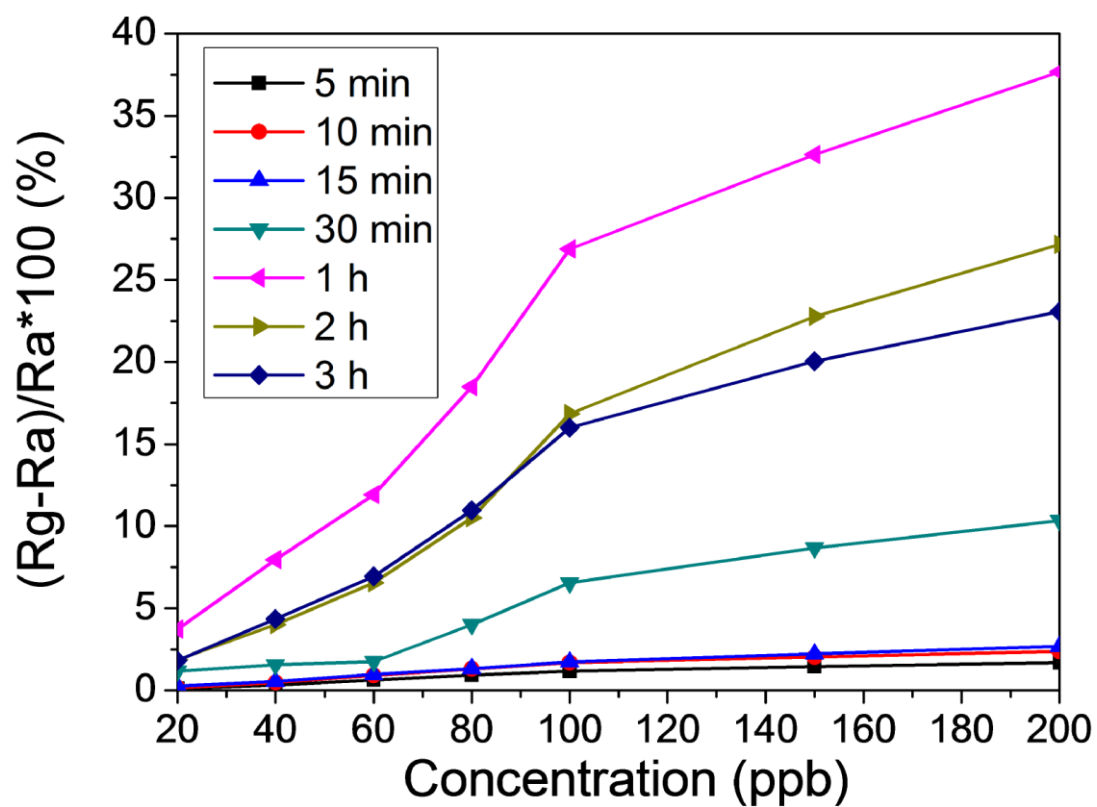
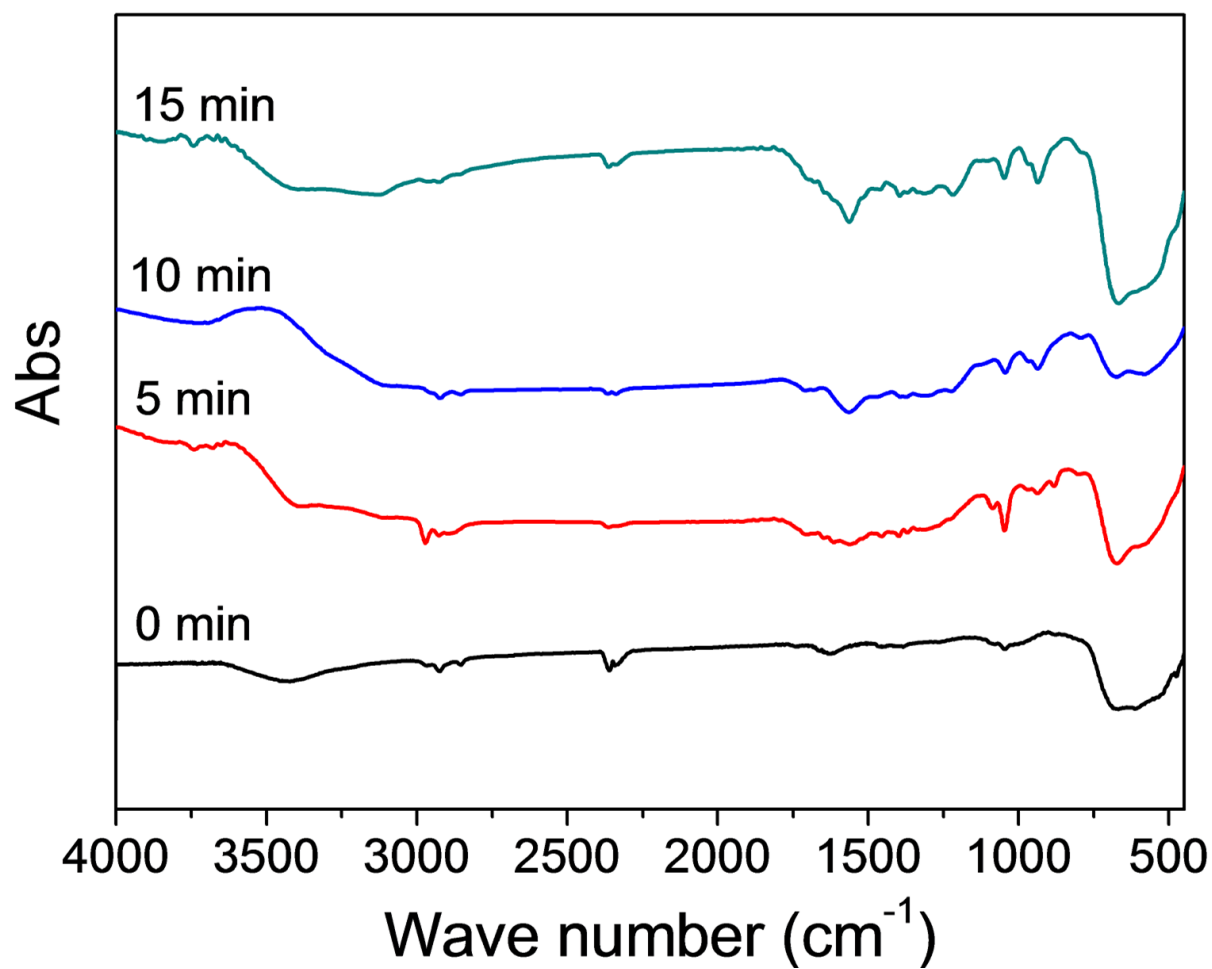
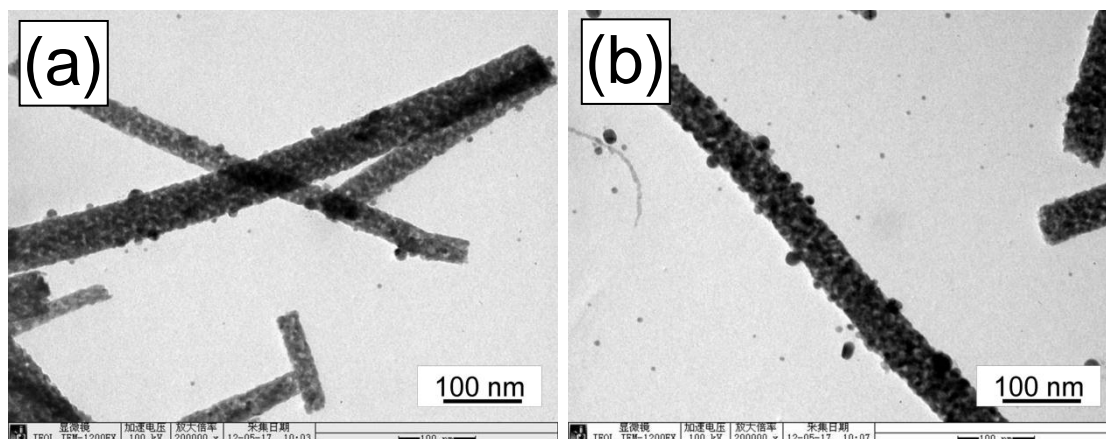


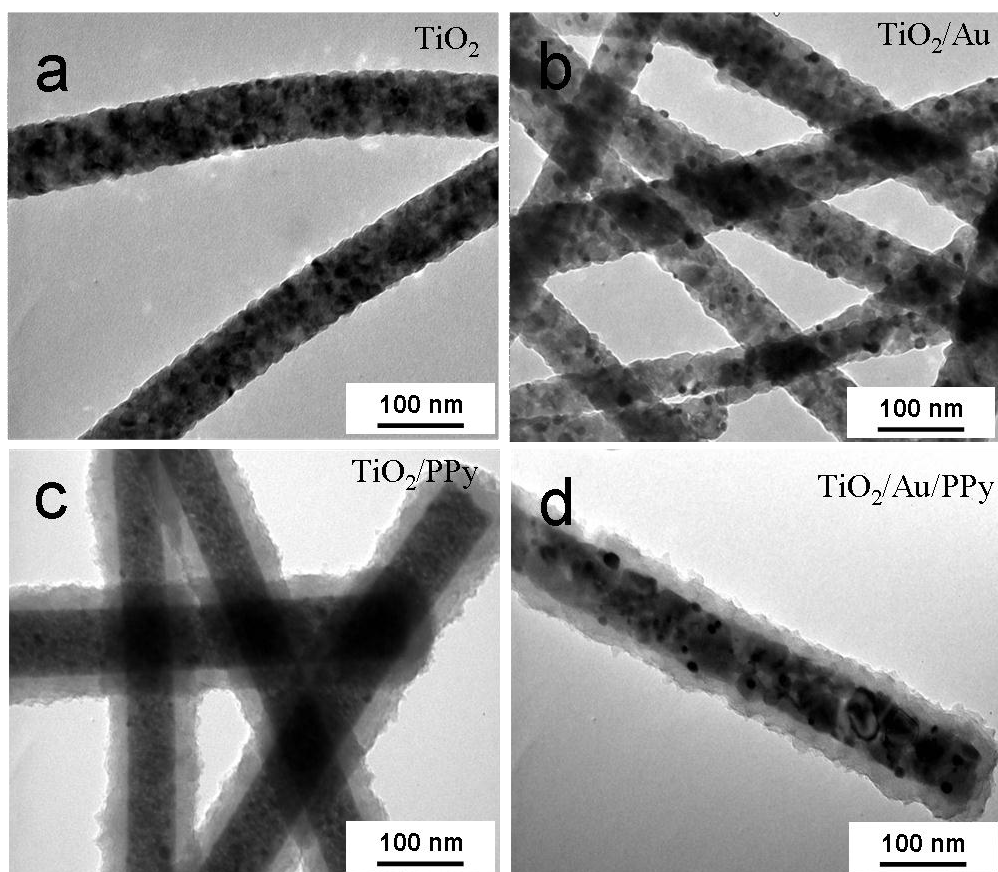
Fig. S1. Response variation versus  $\text{NH}_3$  concentrations (20-200 ppb) of  $\text{SnO}_2/\text{PPy}$  hybrid nanofibers with different polymerization time at room temperature.



**Fig. S2.** FT-IR patterns of SnO<sub>2</sub>-PPy hybrid nanofibers with short polymerization time (0, 5, 10, 15 min).



**Fig. S3.** TEM images of SnO<sub>2</sub>/Ag/PPy composite nanofibers with different polymerization time (a) 10 min and (b) 1 h.



**Fig. S4.** TEM images of (a) TiO<sub>2</sub> nanofibers; (b) TiO<sub>2</sub>/Au nanofibers; (c) TiO<sub>2</sub>/PPy core-shell nanofibers; (d) TiO<sub>2</sub>/Au/PPy core-shell nanofibers.



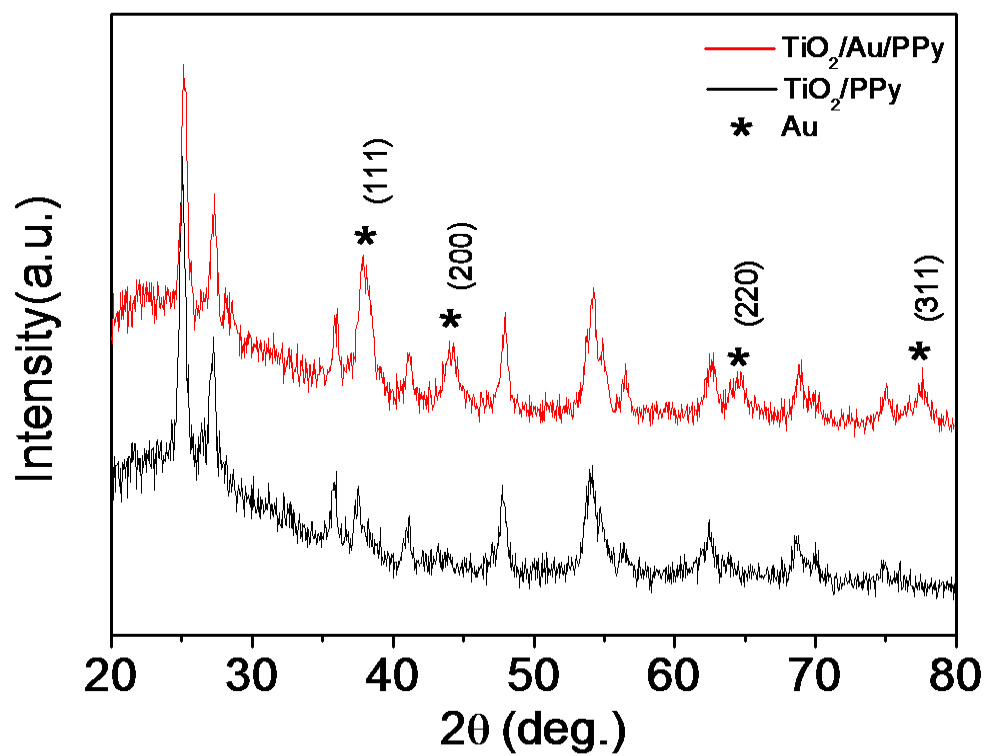


Fig. S5. XRD patterns of  $\text{TiO}_2/\text{PPy}$  and  $\text{TiO}_2/\text{Au}/\text{PPy}$  core-shell nanofibers.