

## Electronic Supplementary Information (ESI)

# Assembly Synthesis of Cu<sub>2</sub>O-on-Cu Nanowires with Cu<sub>2</sub>O Induced Visible-light Enhanced Photocatalytic Activity

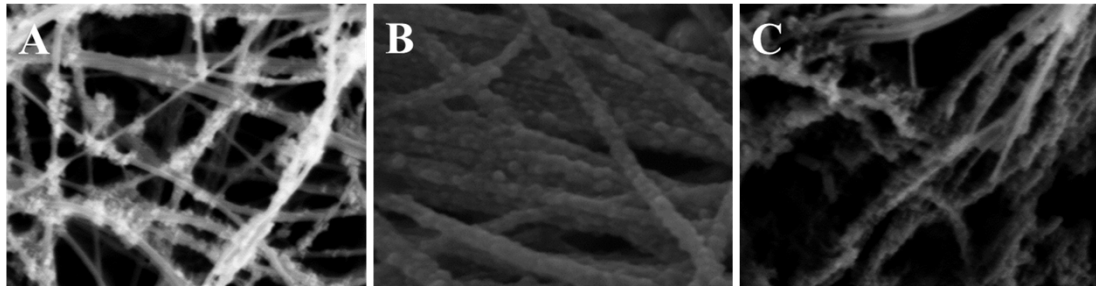
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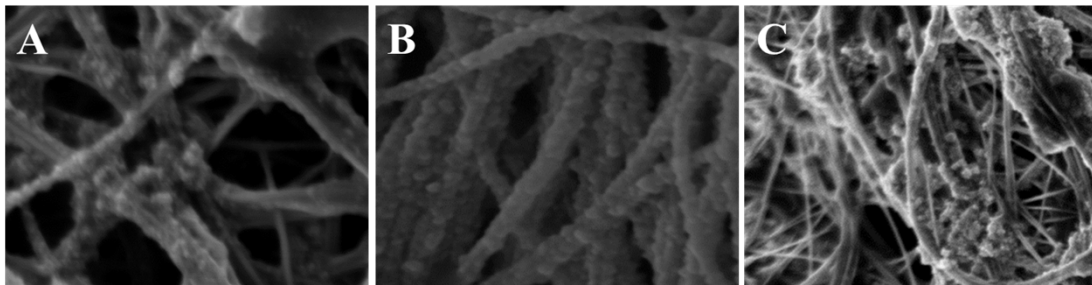
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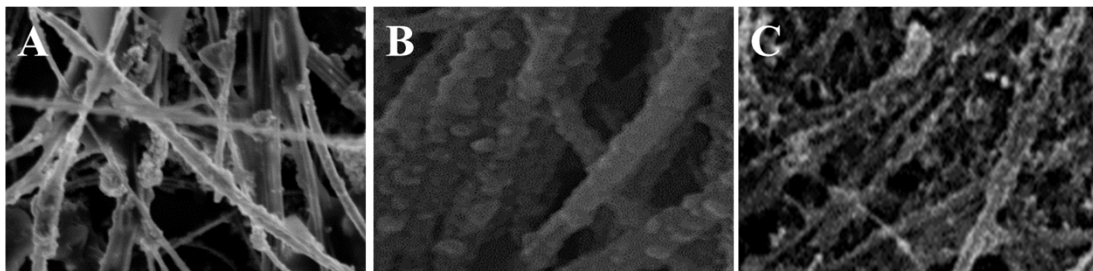
**Figure S1.** SEM images of  $\text{Cu}_2\text{O}$ -on-Cu NWs synthesized with different concentration of  $\text{Cu}_2\text{O}$  precursor solution A) 3mM, B) 5mM, and C) 7mM.

Figure S1 illustrates the SEM images monitored at different concentration of  $\text{Cu}_2\text{O}$  precursor solution for the formation of  $\text{Cu}_2\text{O}$ -on-Cu NWs. It can be observed that  $\text{Cu}_2\text{O}$  NPs arrange along the Cu NWs clearly and densely under the precursor solution concentration of 5mM.



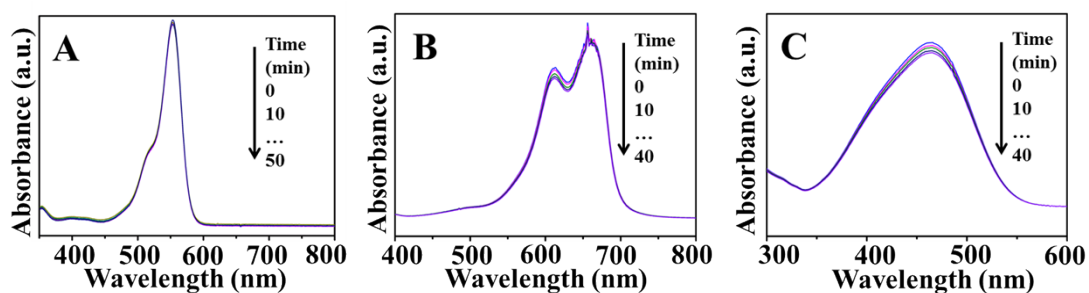
**Figure S2.** SEM images of Cu<sub>2</sub>O-on-Cu NWs synthesized under different heating temperature of A) 30°C, B) 50°C, and C) 70°C.

Figure S2 shows Cu<sub>2</sub>O-on-Cu NWs can be fabricated uniformly under 50°C heating temperature, neither sparsely with the temperature of 30°C nor aggregation of Cu<sub>2</sub>O NPs with the temperature of 70°C.



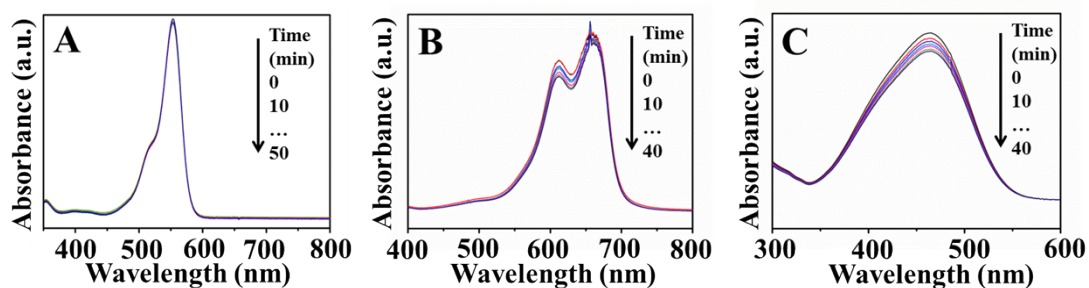
**Figure S3.** SEM images of  $\text{Cu}_2\text{O}$ -on-Cu NWs prepared by different reaction time of A) 30 min, B) 60 min and C) 90 min.

Figure S3 presents that different time can influence the formation of loading process, as it can be obviously observed that  $\text{Cu}_2\text{O}$  loaded on Cu NWs densely and uniformly only through 60 min's heating.



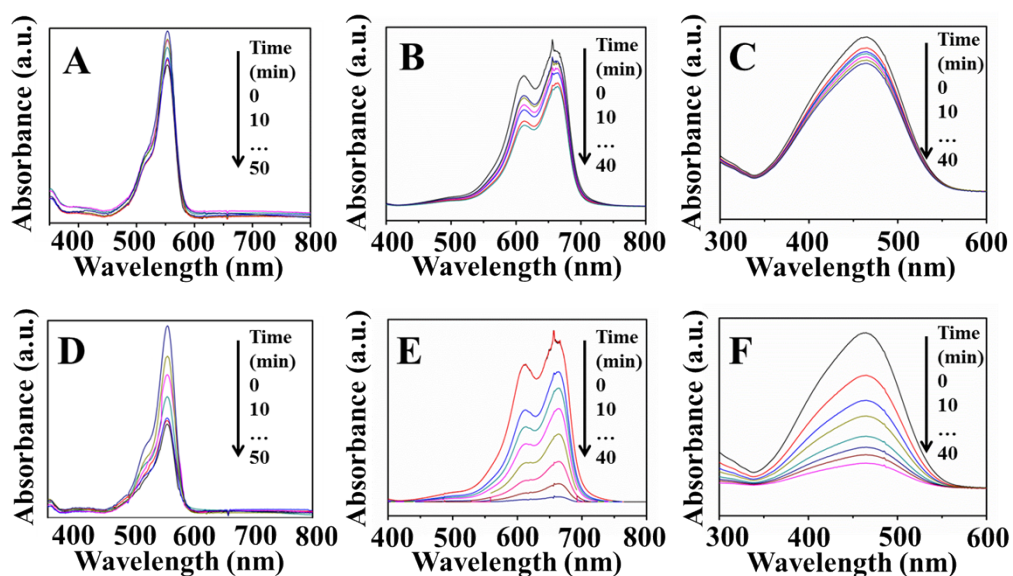
**Figure S4.** UV-vis absorption spectra of different reaction solutions without catalysts: (A) RhB; (B) MB; (C) MO.

In order to exclude the possibility of dye pollutants' self-photodegradation, the control experiments of blank samples are proceeding, and shown in Figure S4. The visible-light irradiation does not degrade RhB, MB and MO solution without catalysts. So the self-photo-sensitized degradation of dye pollutant under present experimental conditions could basically be ignored.



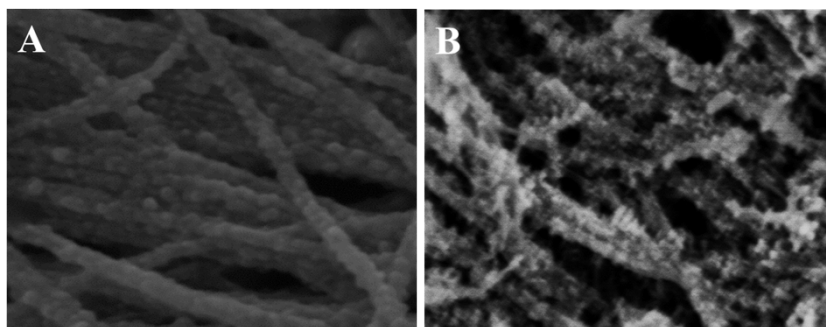
**Figure S5.** UV-vis spectra of the photocatalytic degradation of (A) RhB; (B) MB; and (C) MO catalyzed by bare Cu NWs.

Figure S5 shows the UV-vis spectra of dye pollutants solution which was carried out under visible-light irradiation in the presence of Cu NWs, in order to exclude the possibility that the degradation of dye pollutants was caused by the bare Cu NWs. It can be clearly observed that the Cu NWs does not catalyze the degradation of dye pollutants including RhB, MB, and MO.



**Figure S6.** UV-vis spectra of the photocatalytic degradation of A) RhB, B) MB, and C) MO catalyzed by Cu<sub>2</sub>O NPs; UV-vis spectra of the photocatalytic degradation of D) RhB, E) MB, and F) MO catalyzed by Cu<sub>2</sub>O-on-Cu NWs.

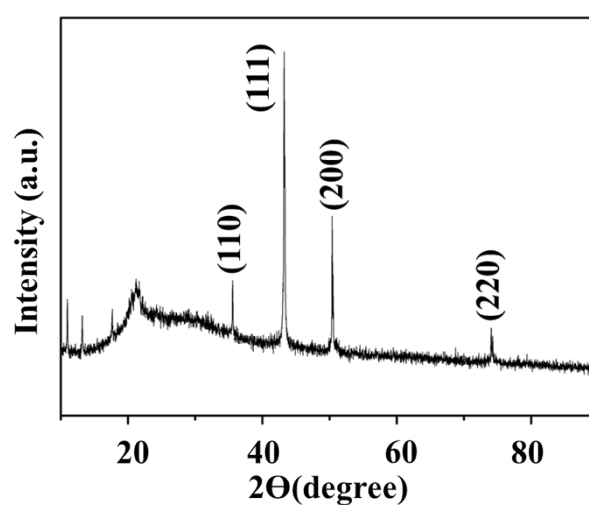
The photocatalytic degradation of RhB, MB, and MO over Cu<sub>2</sub>O-on-Cu NWs together with Cu<sub>2</sub>O NPs has been tested respectively under same condition. Their UV-vis spectra have been given in Figure S6. The photodegradation of RhB, MB, and MO can be slightly catalyzed by Cu<sub>2</sub>O NPs which is unsatisfactory; however, such dye pollutants can degrade totally catalyzed by Cu<sub>2</sub>O-on-Cu NWs which is much higher than the control samples (Cu<sub>2</sub>O NPs).



**Figure S7.** SEM images of Cu<sub>2</sub>O-on-Cu NWs morphology before the catalysis (A), and after seventh reuse (B).

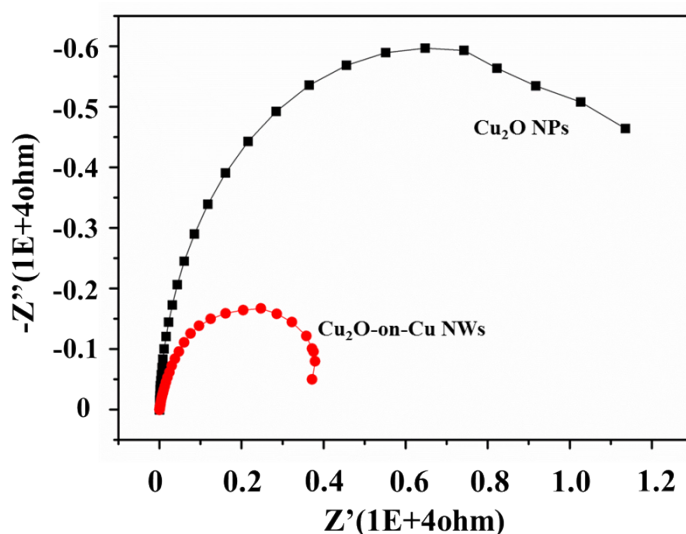
Figure S7 presents the SEM images of Cu<sub>2</sub>O-on-Cu NWs monitored at different reaction time for the catalysis process of MB. After catalyzed for seven times, the 1D structure has slightly deformed but Cu<sub>2</sub>O NPs can still be observed without obvious collapse. Thus, the as-prepared Cu<sub>2</sub>O-on-Cu NWs nanocatalyst has well stability for the degradation of dye pollutants MB.





**Figure S8.** XRD pattern of the Cu<sub>2</sub>O-on-Cu NWs after the degradation of MB.

The XRD pattern of Cu<sub>2</sub>O-on-Cu NWs after the degradation of dye pollutants is nearly the same as that before the catalysis (Figure 2 Cc) and it matches to the mechanical superposition of Cu and Cu<sub>2</sub>O patterns, it indicates that the phase structure of catalysts didn't change during the catalyzing process.



**Figure S9.** Examples of zoomed electrochemical impedance spectra of electrochemical workstation in the low-frequency region.

Electrochemical Impedance Spectroscopy (EIS) is an effective tool to study electrolyte effects on electron transport and recombination at the photoanode. The electrolyte also affects electron transport and recombination because charge transfer can occur from semiconductor to electrolyte (in our experiment is dye pollutants) at their interface. An effective electrolyte would be capable of suppressing charge transfer or recombination at the semiconductor/electrolyte interface while supporting efficient charge transport on the semiconductor side. In this work, we have measured EIS to analyze the electrochemical properties. And we can deduce that the recombination rate of photoproducted electron is low. As shown in Figure S9, it can be obviously observed that Cu<sub>2</sub>O-on-Cu NWs have relatively much lower resistance than that of Cu<sub>2</sub>O NPs, it indicates that our strategy could effectively enhance the conductivity and facilitate the oxide reactions at the catalysts/dye pollutants interface. It can be analyzed that the Cu<sub>2</sub>O-on-Cu NWs have a good ability of electron transport for the photocatalysis. And it reveals that during the catalysis process, Cu NWs can transport the photoinduced electrons effectively and lower the recombination rate of photoinduced electron/vacancy pairs which further enhance the catalytic performance. The photocatalytic mechanism was partially proved.

