Electronic Supplementary Information

Direct coating of gold nanolayers to enhance the oxidation resistance of copper nanowire flexible transparent conductive films†

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Supplementary figures

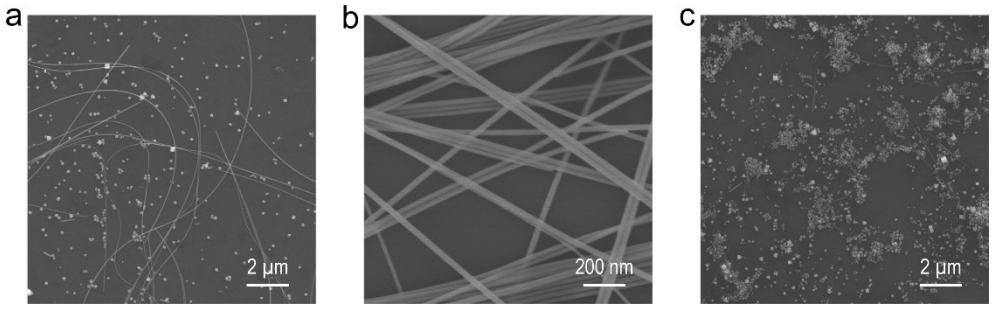

Fig. S1. SEM images of Cu nanowires (a) before and (b) after purification. (c)SEM image of the impurity among purification process.

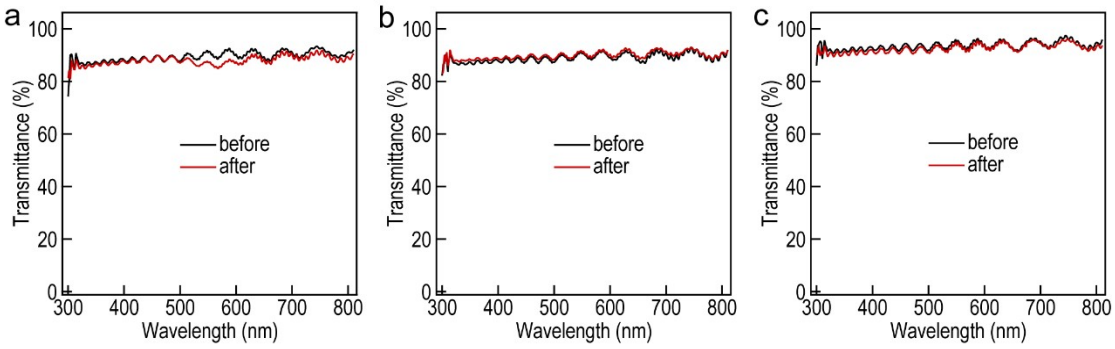

Fig. S2. Film transmittance before and after treatment with different concentrations (0.025, 0.25, 2.5 mM) of $HAuCl_4$.

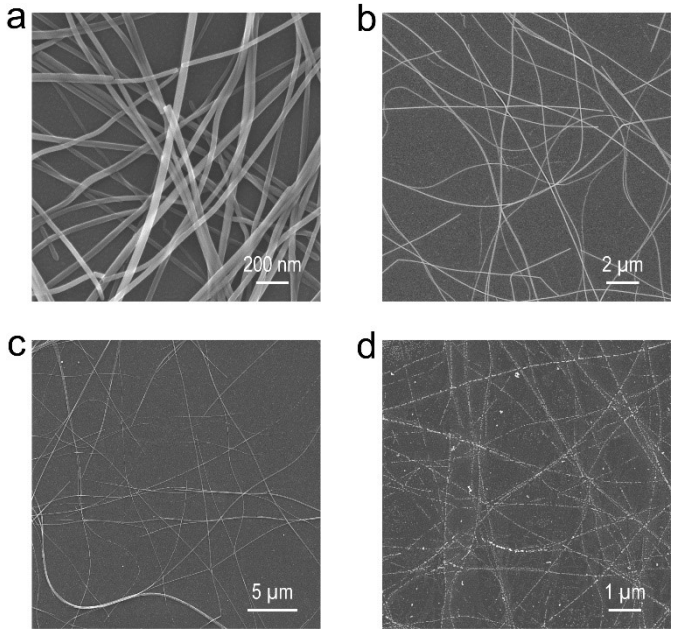

Fig. S3. SEM images of films (a) before and (b) after 0.025 mM $HAuCl_4$ treatment. (c) after 0.25 mM $HAuCl_4$ treatment. (d) after 2.5 mM $HAuCl_4$ treatment.

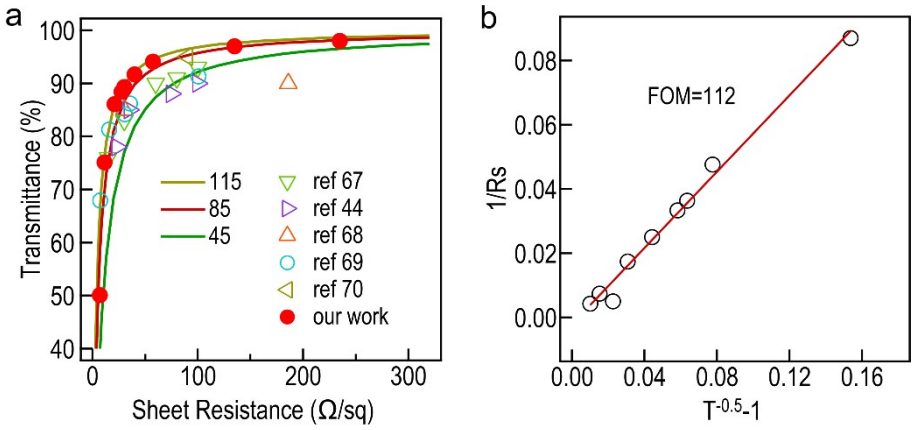

Fig. S4. (a) A plot of the optical transmittance (λ = 550 nm) versus sheet resistance for Cu NWs/PET films. The solid line indicates the fit to eq (1) for $\sigma_{DC}/\sigma_{OP} = 45$ (blue), 85 (yellow), or 115 (pink). The previously reported values are also shown for comparison. (b) A plot of 1/Rs as a function of ($T^{-0.5}$−1) for the Cu NW/PET films.

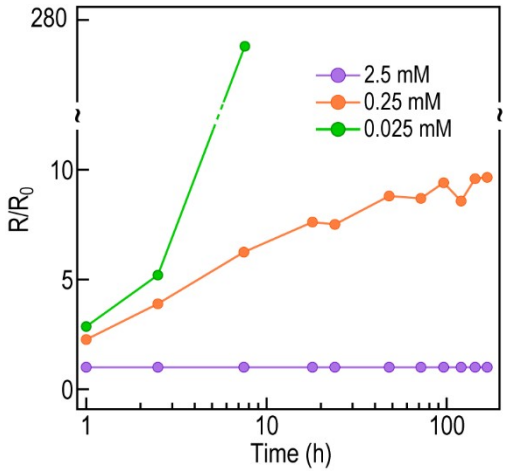

Fig. S5. Stability of the Cu@Au NWs/PET films in high temperature and high humidity environment (temperature = 80 °C, humidity = 80 ± 5%).

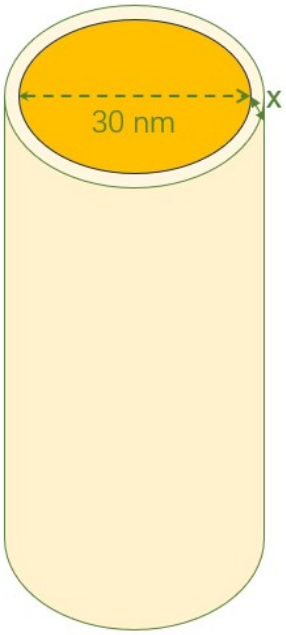

Fig. S6. Schematic model of the size of Cu@Au core and shell.

Analysis of the composition of Cu@Au NW:

In this context, it is posited that the nanowires exhibit full atom occupancy without any gaps. The Au shell's thickness is designated as x nanometers. The Number of Au atoms can be calculated as follows:

$$N_{Au} = \frac{v_{Au}}{\frac{4}{3}\pi r_{Au}^{3}}$$

Where v_{Au} is defined as:

$v_{Au} = \pi\left((15 + x)^2 - 15^2\right) * h$

The number of Cu atoms can be computed as:

$$N_{Cu} = \frac{v_{Cu}}{\frac{4}{3}\pi r_{Cu}^3}$$

Where v_{Cu} is represented by:

$v_{Cu} = 15^2\pi * h$

Considering the Molar ratio of Cu to Au: $n_{Cu}{:}n_{Au} = 95{:}5$ (determined via surface scanning with energy-dispersive spectroscopy), and x~0.56nm, the number of layers of gold atoms can be approximated as:

$$N = \frac{x}{d_{Au}} = \frac{0.56}{0.268} \approx 2$$

Supplementary tables

Table S1 Performance comparison between our films and other films.

Ref.	**Dimensions**	**Photoelectric performance**	**Base**	**Protective metal**	**Thickness of protective layer**	**Stability**
Ref. 1	Average Width:75±19 nm Average Length:28.4±7.1 μm	60 Ω/sq at 84.3%	Glass	Ni	~41 nm	30 days
Ref. 2	Average Width:21±4nm Average Length: 10-20 μm	50 Ω/sq at 90%	Glass	Au	~2 nm	712 hours
Ref. 3	Average Width: ~35 nm Average Length: >50 μm	62.4 Ω/sq at 80%	PDMS	Ni	~10 nm	3 years
Our Work	Average Width: 27 nm Average Length: >10 μm	30 Ω/sq at 90%	PET	Au	~1 nm	>75days

References

(1) A. R. Rathmell, M. Nguyen, M. Chi, B. J. Wiley, *Nano Lett.*, 2012, **12**, 3193−3199.

(2) Z. Q. Niu, F. Cui, Y. Yu, B. Nigel, Y. C. Sun, K. Garo, D. Kim, L. Dou, D. Ahmad, S. Kerstin and P. D. Yang, *J. Am. Chem. Soc.*, 2017, **139**, 7348–7354.

(3) J. Z. Song, J. H. Li, J. Y. Xu and H. B. Zeng, *Nano Lett.*, 2014, **14**, 6298–6305.