Supplementary Information

An eco-friendly water-assisted polyol method to enhance aspect ratio of silver nanowires

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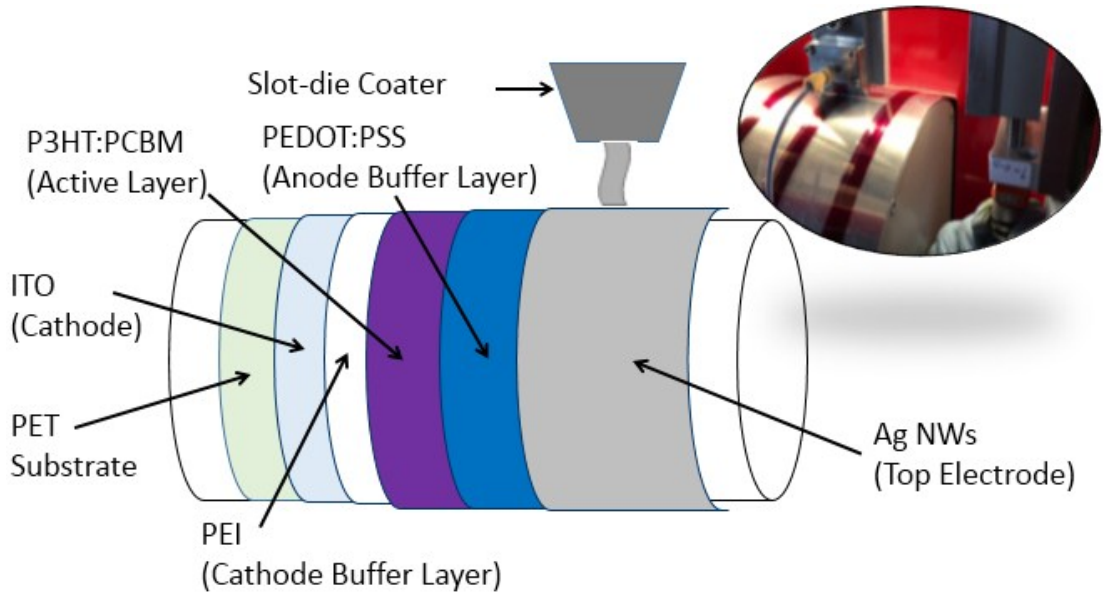

Fig.S1 The slot-die coating of inverted semi-transparent OSCs with printed Ag NWs top electrodes. The photo inset upper right showed the slot-die coating operation.

The coating parameters changed were the injection speed (I), coating speed (v) and temperature of the roll (T). PEI (Mw = 10000) dispersed in isopropyl alcohol (0.1 wt %) is coated on flexible substrates (I = 0.1 µm/min, v= 1 m/min, T= 40 °C) and the layer was dried at 40 ^{o}C for 10 min. P3HT (Mw = 30,000) purchased from J&K and PCBM (technical grade 99 %) from Sigma, were both dissolved at a concentration of 20 mg/ml in a volume ratio 1:1 in o-xylene and stirred for 15 min at 80 °C before coating. The photoactive layer (PAL) was then coated on flexible substrates (I = 0.2µm/min, v = 1 m/min, T = 40 °C). 25 mL PEDOT:PSS (Sigma, 1 % in H_2O) was mixed with 1.5 mL diethylene glycol (DEG, 99 %, sigma) and 125 µL fluorinated surfactant (Capstone®FS-31, Dupont), then coated (I= 0.3µm/min, v= 1 mL/min, T= 40 °C) and dry at 100 °C for 5 min. The devices were completed by slot-die coating (I= 0.3µm/min, v= 0.6 m/min, T= 60 °C) the as prepared Ag NWs from ethanol solution (0.5 mg/ml). Finally, the devices were annealed at 120 °C for 5 min.

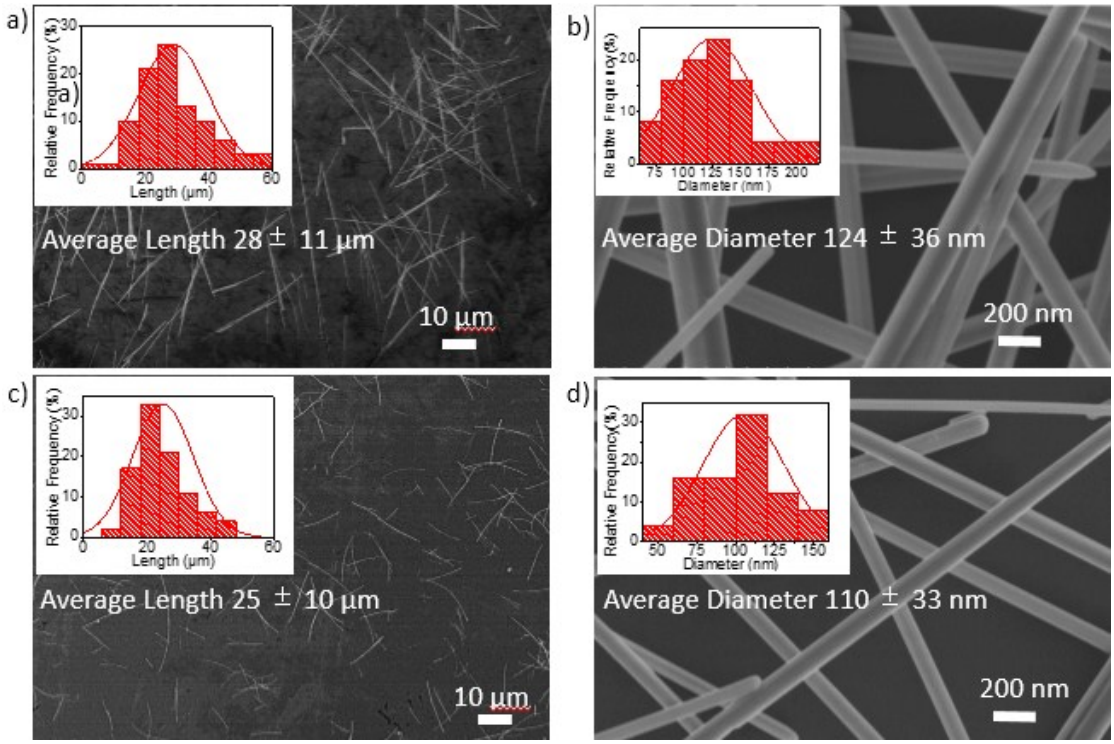

Fig S2. The SEM of Ag NWs synthesized with PVP of molecular weight 58000 by (a,b) water-assisted and (c,d) waterless polyol method

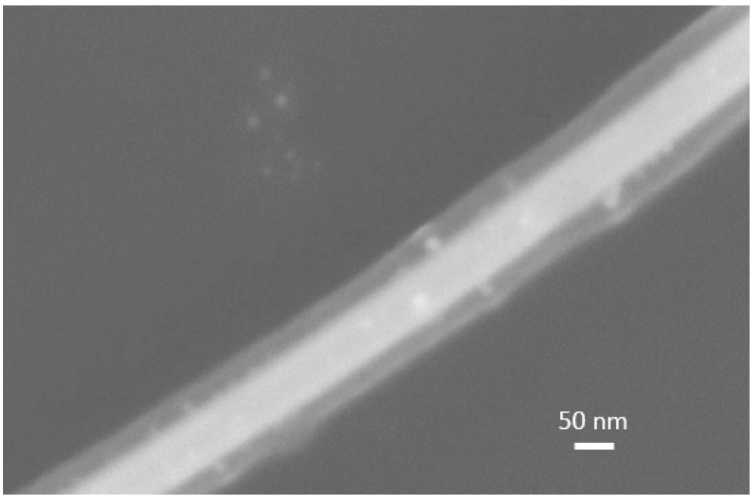

Fig S3. The core-shell structure of Ag NWs made by PVP of molecular weight 1300000 without water

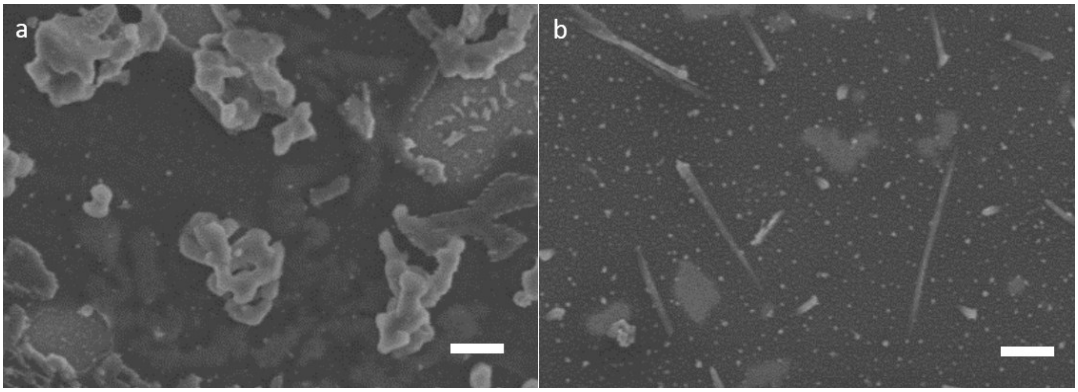

Fig S4. The SEM of Ag NWs reacted for 5 minutes: a) without water and b) with water. The scale bar is 1 µm.

Table. S1 The performance of TCF made from different type AgNWs and solvents

Polyol Progress	solvent	$R_{\square}/\Omega$	transmittance	Haze	Figure of Merits (F.O.M)
Waterless	Methanol	21.2	75.1%	8.65%	58
Waterless	Ethanol	19.3	80.9%	8.50%	87
Water-assisted	Methanol	9.3	76.8%	5.08%	143
Water-assisted	Ethanol	8.1	81.9%	4.68%	222

Generally, the transmittance and sheet resistance for thin conduct films are related by the equation followed:[1,2]

$$\mathrm{T} = (1 + \frac{1}{2\,\mathrm{Rs}}\sqrt{\frac{\mu_0}{\varepsilon_0}}\frac{\sigma_{op}}{\sigma_{dc}})^{-2} = (1 + \frac{188.5}{R_S}\frac{\sigma_{op}}{\sigma_{dc}})^{-2}$$

σ_{dc}: direct current conductivity; σ_{op}: Optical rate; μ_0: permeability of vacuum; ε_0: permittivity of vacuum ; R_S: sheet resistance ; T: light transmittance

The ratio of the DC conductivity to the optical conductivity, σ_{dc}/σ_{op}, was often used to evaluate the performance of transparent conductors, so F.O.M equals σ_{dc}/σ_{op}

Haze is another important parameter for TCE in addition to transparency and sheet resistance. It's calculated by the ratio of diffuse transmission and total transmission while diffuse transmission is strongly related to light scattering of surface.

Table. S2 The aspect ratio of Ag NWs made by different polyol progresses

FACTOR / EXPNO	H_2O addition time	H_2O/EG（vol%）	Mw(PVP)	Aspect ratio（L/D）
1	NA	NA	58,000	~227
2	NA	NA	1,300,000	~280
3	With $AgNO_3$	2%	1,300,000	~180
4	With AgCl	2%	58,000	~225
5	With AgCl	1%	1,300,000	~500, lots of nanoparticles
6	With AgCl	2%	1,300,000	~1600, the best
7	With AgCl	4%	1,300,000	~240, lots of particles & nanorods

Typical polyol progress:

EG + PVP (heat 30 min) → adding of AgCl (stir 5 min) → slow injection of $AgNO_3$ (10 min) → react 30 min

1. D. S. Hecht, L. Hu and G. Irvin, *Advanced materials*, 2011, **23**, 1482-1513.

2. Y. Liu, Y. Chen, R. Shi, L. Cao, Z. Wang, T. Sun, J. Lin, J. Liu and W. Huang, *RSC Adv.*, 2017, **7**, 4891-4895.