Supporting Information

Electrical Switch for Smart pH Self-Adjusting System Based on Silver Nanowire/Polyaniline Nanocomposite Film

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Video

Video 1: A typical pH self-adjusting process of the smart system.

Characterization of silver nanowires

Figure S1 shows the SEM and TEM images of the as-synthesized silver nanowires (Ag-NWs). The Ag-NWs have an average length of 25.7 μm and an average diameter of 187 nm. The data were obtained from 100 stochastic measurements in terms of the SEM images of the Ag-NWs using Nano Measure software.

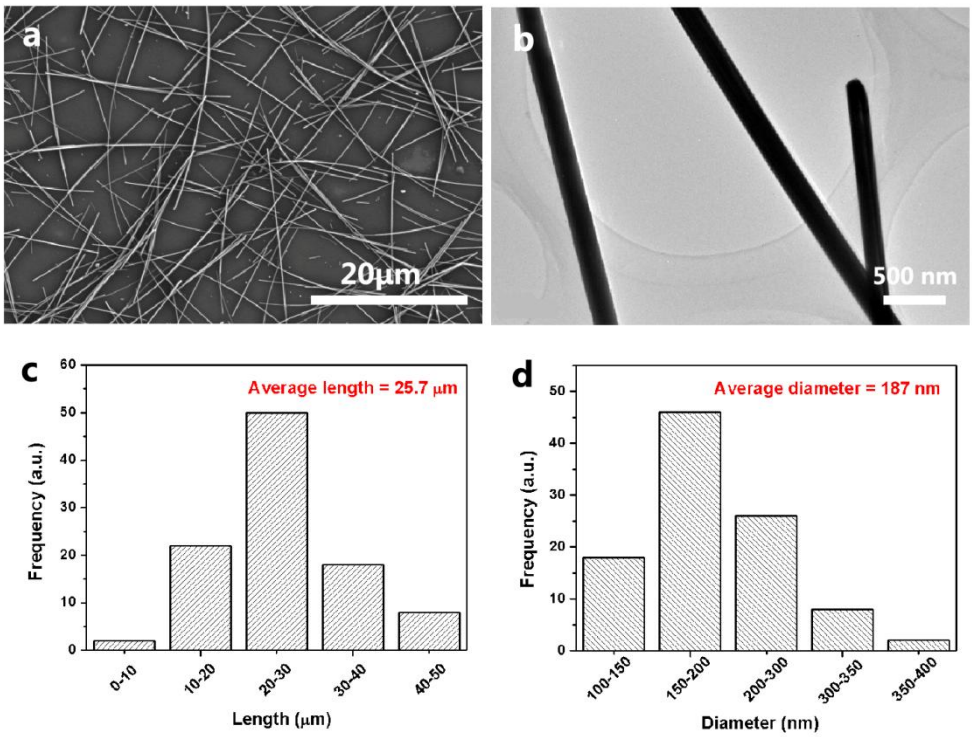

Figure S1. (a) SEM image and (b) TEM image of the Ag-NWs; histograms for (c) the length and (d) the diameter of the Ag-NWs.

Evaluation of the contact resistance between Ag-NW layer and PANI layer

In order to evaluate the contact resistance (R_C) between Ag-NW layer and PANI layer, the conductivity of the Ag-NW layer has to be obtained first. It can be calculated from the tested result ofthe bulk conductivity of the composite film. The resistance of the composite film can be got from the resistance of the silver layer and that of the PANI layer in terms of a parallel circuitas described in **Figure S2a**. Then we get

$$\frac{1}{R}=\frac{1}{R_{PANI}}+\frac{1}{R_{Ag}}$$

in which $R=\frac{l}{\sigma\times w\times t}$, where σ, l, w and t are the conductivity, length, width and thickness of the sample, respectively. Thus, we can have

$$\frac{\sigma wt}{l} = \frac{w}{l}(\sigma_{Ag} t_{Ag} + \sigma_{PANI} t_{PANI})$$

in which $t_{PANI} = t\text{-}t_{Ag}$ and $t_{Ag} = \frac{\rho_S}{\rho_{Ag}}$, where ρ_S is the areal density of the Ag-NWs in the composite film. ρ_{Ag} (=3.5 g cm^{-3}) is the bulk densityof the Ag-NWs. Thus, the conductivity (σ_{Ag}) of the Ag-NW layer can be calculated from the following **Equation S1**:

$$\sigma_{\mathrm{Ag}} = \frac{\rho_{Ag} t\left(\sigma - \sigma_{PANI}\right)}{\rho_S} + \sigma_{PANI} \qquad \text{(S1)}$$

The conductivity of the neat PANI is measured to be 4.8 S/cm and the measured values of σ and *t* are substituted into Equation (S1), σ_{Ag} can then be obtained. The results are given in **Figure S2b**.

Base on the above obtained Ag-NW layer conductivity, the contact resistance can then be evaluated now. Since the sheet resistance of the PANI-side (R_p) can be measured, the contact resistance (R_C) between layers and the resistance of the silver layer (R_{Ag}) areserially connected. Thus, as a whole resistance, they are parallel connected with the resistance of the PANI layer (R_{PANI}), as described in **Figure S2c**. Hence,we have

$$\frac{1}{R_P} = \frac{1}{R_{PANI}} + \frac{1}{R_{Ag} + 2R_C}$$

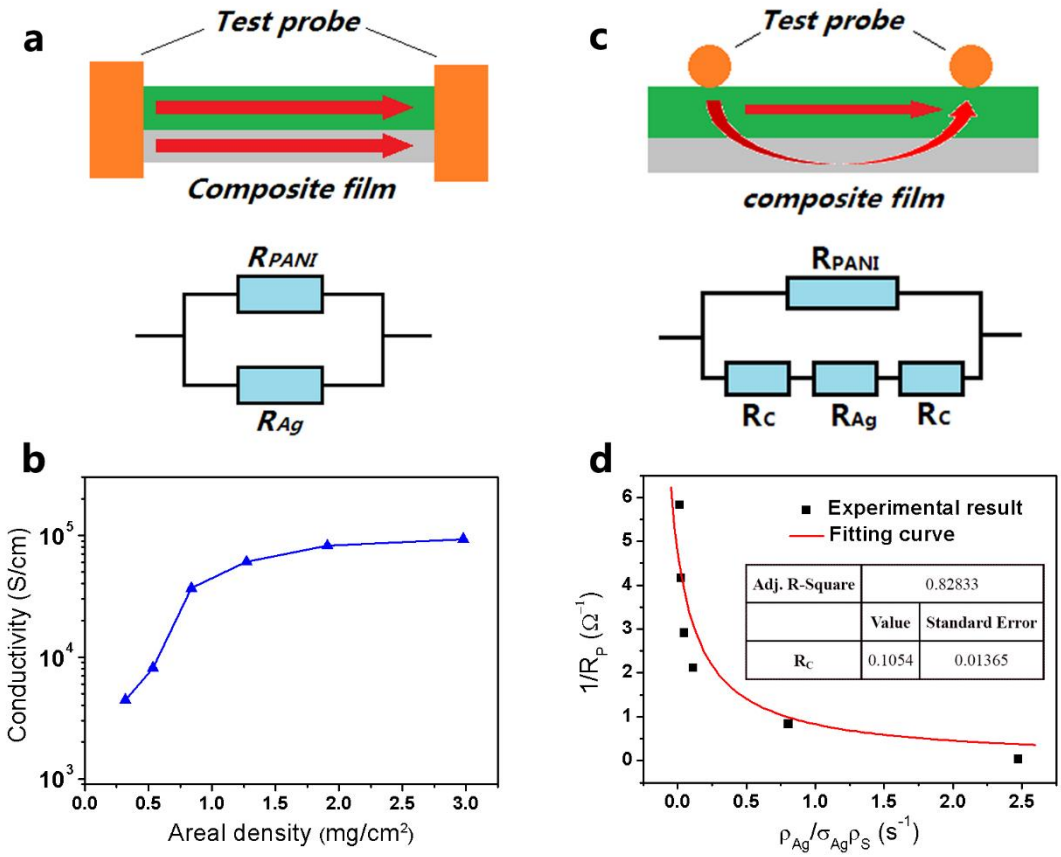

Figure S2. (a) Schematic diagram of the equivalent resistance of the bulk conductivity test, (b)schematic diagram of the PANI-side sheet resistance test, (c) the Ag-NW layer conductivity as a function of its areal density and (d) fitting curve of the conductivity of the Ag-NW/PANI composite film versus the silver layer resistance.

Namely,

$$\frac{1}{R_P}=\frac{R_{PANI}+R_{Ag}+2R_C}{R_{PANI}R_{Ag}+2R_{PANI}R_C}$$

Substituting $R=\frac{l}{\sigma\times w\times t}$ and w=l into the above equation,we then get

$$\frac{1}{R_P}=\frac{1/\sigma_{PANI}t_{PANI}+1/\sigma_{Ag}t_{Ag}+2R_C}{1/\sigma_{PANI}t_{PANI}\times 1/\sigma_{Ag}t_{Ag}+1/\sigma_{PANI}t_{PANI}\times 2R_C}$$

where the PANI layer thickness $t_{PANI} = \frac{\rho_{S'}}{\rho_{PANI}}$, in which ρ_{PANI} =1.2g/cm^3 is the bulk density of the PANI and $\rho_{S'}$=1.2 mg/cm^2 is the PANI areal density. Substituting the PANI conductivity and the PANI layer thickness into the above equation, we get **EquationS2**:

$$\frac{1}{R_P} = \frac{208.3 + \rho_{Ag} / \sigma_{Ag} \rho_S + 2R_C}{208.3 \rho_{Ag} / \sigma_{Ag} \rho_S + 416.6 R_C} \qquad \text{(S2)}$$

From **Equation S2**, R_C can be derived by fitting the curve of $1/R_P$ against $\rho_{Ag} / \sigma_{Ag} \rho_S$. **Figure S2d** shows the fitting result, in which the R_C is calculated to be about 0.11 Ω square^{-1}.