Supplementary Information for:

Growth control of AgTCNQ nanowire arrays by using template-assisted electro-deposition method

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General.

Fabrication of AAO template. The templates with smaller interspacing distance (~110 nm) are prepared by oxidization of aluminum foil under constant voltage of 40 V in 0.3 M oxalic acid. The templates with larger interspacing distance (~400 nm) are obtained by oxidization of aluminum foil under constant voltage of 160 V in 0.4 M phosphoric acid. Before oxidization, the aluminum foils are rinsed in acetone and water to remove the adsorbed contamination and electro-polished in perchloric acid (in ethanol with volume ratio of 1:7) under 30 V. After oxidization, template with nanopore diameter about 40 nm and 200 nm are obtained respectively. Pore-widening process is conducted in 5 wt% phosphoric acid to remove the back barrier layer and enlarge the diameters of nanopores.

Electrochemical deposition. The electro-deposition are conducted in the constant voltage mode with three electrode system of BioLogic VSP potentiostat, containing an Ag/AgCl reference electrode and a Platinum foil counter electrode, or in the constant current mode with two electrode system by using Pt foil as counter electrode. The electrolyte is consisted of 30 mM AgNO₃, 6 mM TCNQ and 0.1 M Bu_4NPF_6 as supporting electrolyte in acetonitrile. The template was removed by KOH (1 M) after electro-deposition for further characterization.

Characterization. The SEM images and EDS spectra are taken by using a Hitachi S4800 instrument employing voltages of 5 kV and 10 kV, respectively. The TEM images and SAED patterns are achieved on an FEI TECNAI 20 S-TWIN system with an acceleration voltage of 200 kV and using a CCD camera. The XRD measurements are recorded on a D5000 X-ray diffractometer (Bruker AXS, Cu-Kα radiation) equipment.

Device fabrication and characterization. The electrode arrays (Ti/Au of 5/30 nm respectively) are deposited by using electron-beam lithography on a Raith 150 instrument. Then the suspension of AgTCNQ nanowires in ethanol solution was drop-cast onto the electrode arrays. The current-voltage characteristics and the memories are measured on a Keithley 4200 SCS equipment in air atmosphere.



Fig. S1. SEM images of (a) the back side (b) the cross-section of the template with brenched nanopores by reducing the oxidization voltage.



Fig. S2. XRD patterns of the nanowires obtained from electro-deposition under constant voltage conditions, which can be assigned to FCC silver.



Fig. S3. Smoothed XRD patterns of the nanowires obtained from electro-deposition under constant current conditions, which can be assigned to Phase II of AgTCNQ.



Fig. S4. Crystal structure of AgTCNQ (Phase II): the light gray, dark gray and blue atoms represent Ag, C and N atoms respectively, and the hydrogen atoms are romoved for clearity (RefCode DEHRIR from CSD).



Fig. S5. EDS spectra of the nanorods or nanowires obtained from electro-deposition under (a) constant voltage condition (by using small diameter template (~70 nm)) and (b) constant current condition (by using template with small or large diameter (~70 nm or 200~300 nm)) respectively. It is clear that for the nanorods or nanowires obtained from electro-deposition under constant voltage conditions, only silver element can be detected (a). On the other hand, for the nanowires obtained from electro-deposition under constant current conditions, silver, carbon and nitrogen elements can be detected (b). Together with the XRD patterns and structures of Ag and AgTCNQ (Fig. S4), it can be concluded that the nanorods or nanowires obtained to Ag and AgTCNQ respectively.



Fig. S6. EDS spectra of the nanorods or nanowires obtained from electro-deposition under constant voltage conditions (by using large diameter template (200~300 nm)), in which carbon and nitrogen elements are negligible in spot 1 (especially, nitrogen can not be detected); however, carbon and nitrogen elements can be detected in spot 2 and the intensity of them in the nanowires are much higher than those in spot 1. Besides, due to the different conductivity of Ag and AgTCNQ, the contrast of them should be different in the SEM images, while the nanorods (spot 1) usually are brighter than the long nanowires (spot 2). All of these suggested that the nanorods (spot 1) belong to Ag and the nanowires (spot 2) belong to AgTCNQ respectively. Together with the above analysis in Figure S5, it can be inferred that Ag and AgTCNQ co-existed by using large diameter template under constant voltage conditions.



Fig. S7. (a) SEM image and corresponding elemental mapping of elements (b) C, (b) N and (d) Ag, suggesting the formation of AgTCNQ.



Fig. S8. Supposed mechanism when quick deposition is happened (e.g. controlled by constant voltage conditions, the blue arrows reprensent that the movement of the anions under the negative voltage applied): i) the TCNQ⁻ moves to the top surface due to the applied negative potential, which results in the formation of AgTCNQ on the top surface; ii) the lack of TCNQ and Ag⁺ made the reaction of them with Ag and TCNQ⁻ respectively rarely happened in the nanopores, which led to Ag nanowires in the nanopores.



Fig. S9. (a) Photo image and (b) corresponding cross-polarized light microscopy image of dispersed AgTCNQ nanowires, suggesting its crystalline properties.



Fig. S10. SEM image of a typical device based on an individual AgTCNQ nanowire.