Supporting Information for:

Core-Shell and Segmented Polymer-Metal Composite Nanostructures

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Electrochemical Procedures. Anodized aluminum oxide (AAO) membranes (Whatman, pore size = 0.2 μm, thickness = ~60 μm, area = 2.3 cm^2, density = ~10^8 pores per membrane) were purchased from VWR.

Galvanostatic Deposition of Metal. All electroplating solutions—Oromerse BR Gold, pH ~ 10.2 (gold); Orotemp 24 "C", pH ~ 7.4 (gold); nickel sulfamate RTU (Techni nickel "S"), pH ~ 5.5 (nickel); Techni-silver E-2 (silver), pH ~ 12.5; and Techni Copper PC 75 (copper), pH ~ 3.5—were purchased from Technic, Inc., Cranston RI. All metals were plated at a current density of 0.5 mA/cm^2 using a potentiostat/galvanostat (Princeton Applied Research 273A). Platinum foil served as the counter electrode.

Potentiostatic Deposition of Polyaniline. Aniline (puriss >99.5%, Fluka) was purchased from Aldrich and distilled at 90°C/30 mmHg before use. Electropolymerization using a bipotentiostat (Pine, AFCBP1) was carried out at +0.8 V vs. Ag/AgCl from a solution of 0.1 M aniline in 0.5 M Na_2SO_4, 0.1 M H_2SO_4 (aq, pH ~ 1). Platinum foil served as the counter electrode.

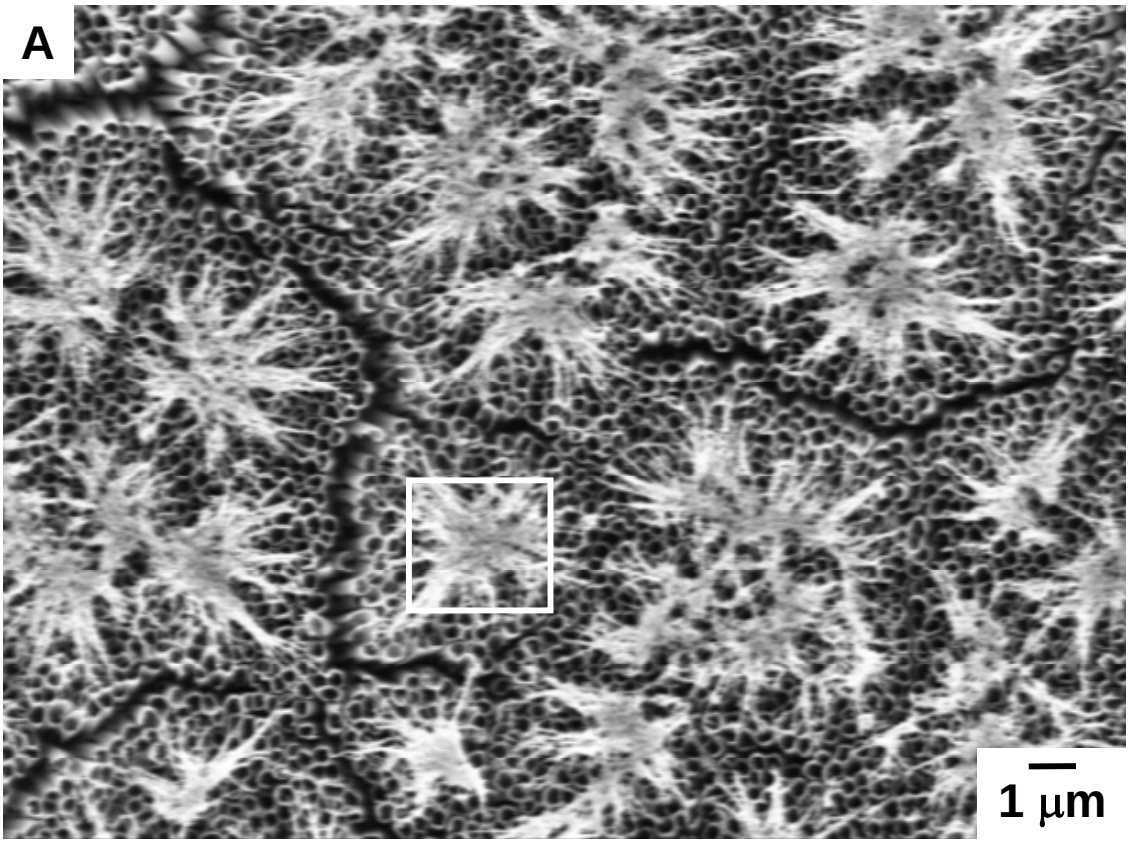
Plasma Etching. To make the gold nanotubes (Figures 3, S1), the PANI-Au core-shell sample was exposed to oxygen plasma (300 mTorr, 18 W) for 5 min using an SPI Plasma Prep II (West Chester, PA).

Scanning Electron Microscopy (SEM) and Electron Backscattered Diffraction (EBSD). For imaging, a small portion of each membrane containing the PANI-metal composite was cut out and placed on an SEM stub (held by conductive carbon tape). The membrane was then dissolved by covering it with a drop of 1 M NaOH for 90 minutes, washing with copious amounts of de-ionized water, and drying in air. The samples were imaged with a Leo SEM (Model 982, resolution: 4 nm at 1 keV) under high vacuum (10^{-7} torr) using a 2-3 keV electron beam. The SEM was equipped with an EBSD system. The EBSD measurements were performed at a working distance of 13 mm, and an electron beam energy of 15 keV.

Figure S1. A) Large-area SEM image of the gold nanotubes pictured in Figure 2. **B**) The EBSD spectrum of the boxed region in Figure S1A (the fibrous material that is tethered to the inside of the gold nanotubes) from 0 – 6 keV and 7.5 – 15 keV (inset). This spectrum identifies the fibrous material as gold.

Scheme S1: Alternate procedure for preparation of the segmented polymer-metal nanostructures (without forming the SAM of thioaniline on the Au rods): **1**) electrodeposition of Au; **2**) electropolymerization of PANI; **3**) dissolution of the AAO membrane. (This method leads to detachment of the PANI tubes from the gold upon dissolution of the membrane.)

Figure S2. SEM images of Au rods (**A**: side view, **B**: top view) that result from Scheme S1.


A
1 μm

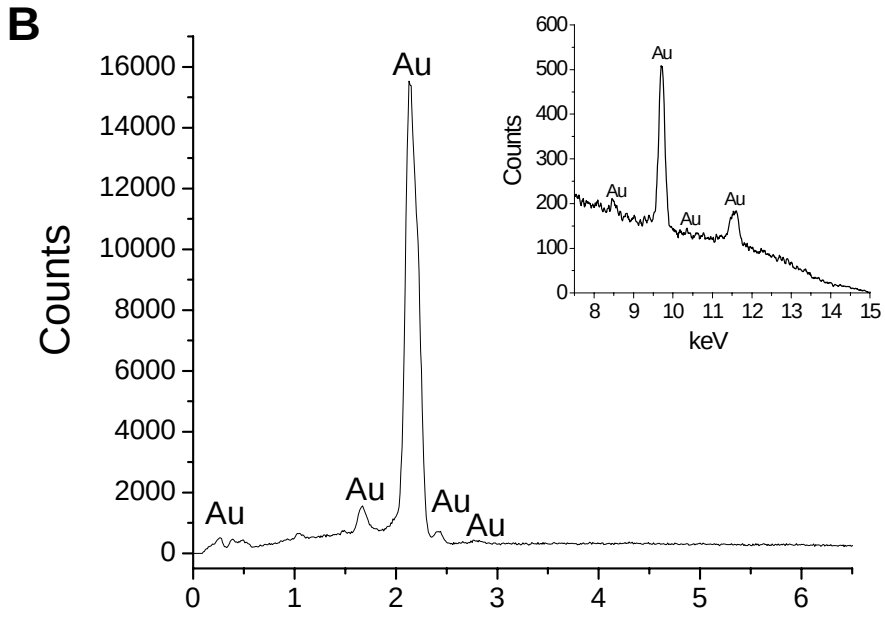
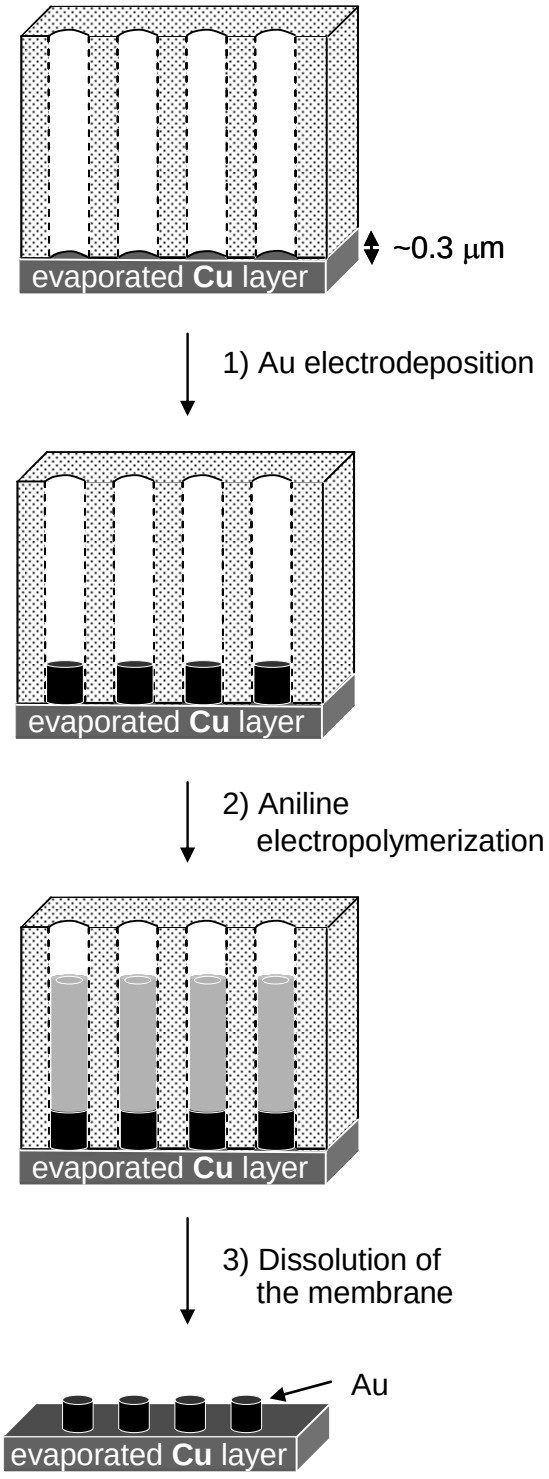

B
Counts
16000
14000
12000
10000
8000
6000
4000
2000
0
0
1
2
3
4
5
6
Au
Au
Au
Au
Au
Counts
600
500
400
300
200
100
0
8
9
10
11
12
13
14
15
keV
Au
Au
Au
Au

Figure S1.


~0.3 μm
evaporated Cu layer
1) Au electrodeposition
evaporated Cu layer
2) Aniline
electropolymerization
evaporated Cu layer
3) Dissolution of
the membrane
Au
evaporated Cu layer

Scheme S1.

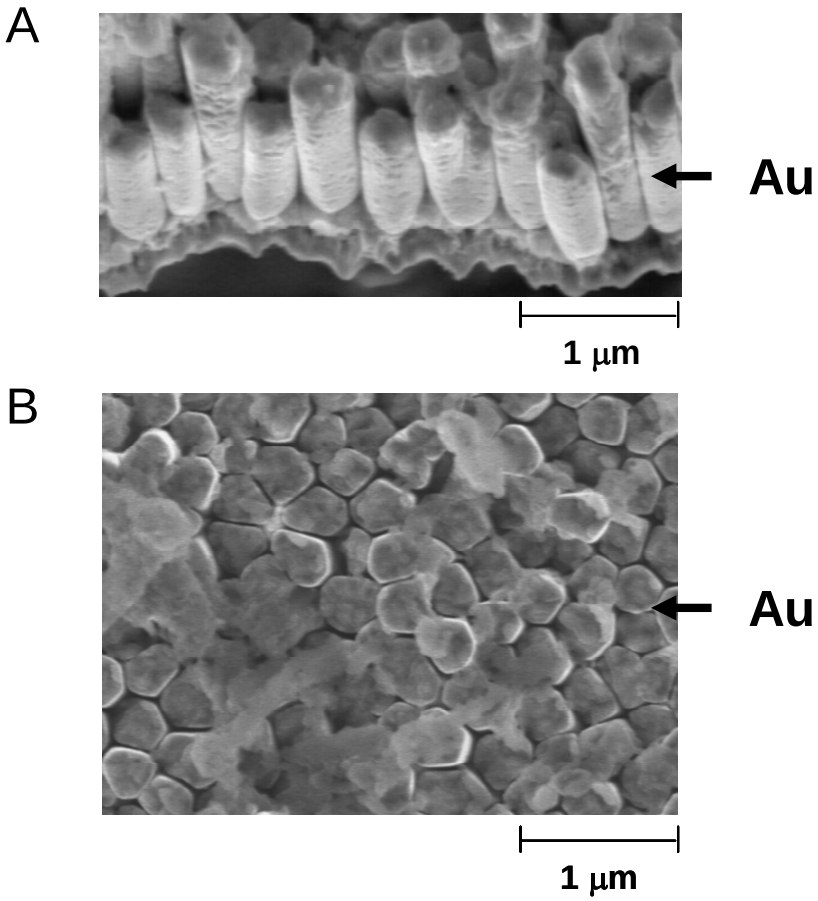


Figure S2.