Supplementary Information

Templated Electrochemical Synthesis of Conducting Polymer Nanowires from Corresponding Monomer Nanoemulsions Prepared by Tandem Acoustic Emulsification

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1. Materials

All chemicals were used without further purification. 3,4-Ethylenedioxythiophene (EDOT) was purchased from Sigma-Aldrich Co.. Lithium perchlorate ($LiClO_4$) was purchased from Kanto Chem. Co.. Distilled and deionized water was used as a solvent for templated electrochemical polymerization.

2. Tandem acoustic emulsification

0.5 mmol of EDOT was added to 25 mL of aqueous solution containing 1.0 M $LiClO_4$ in glass beaker cell. The 20 kHz ultrasonication to the aqueous electrolyte/EDOT mixture was conducted with an ultrasonic stepped horn (13 mm diameter, titanium alloy) connected with a 20 kHz oscillator (44 W cm^{-2}, SONIFIER-250D, Branson Ultrasonics Co.) for 5 min. The sequential ultrasonication with 1.6 MHz treatment after 20 kHz was carried out using an ultrasonic transducer (16 W cm^{-2}, Honda Electric Co.) connected with a Pyrex glass cylindrical tube (diameter, 24 mm; length, 75 mm) for 5 min. The further sequential ultrasonication with 2.4 MHz treatment after 20 kHz and 1.6 MHz was conducted by an ultrasonic transducer (7 W cm^{-2}, Honda Electric Co.) connected with a Pyrex glass cylindrical tube (diameter, 24 mm; length, 75 mm) for 5 min.

3. Preparation of template electrode

We employed the uniform and straight channels of an anodic aluminum oxide membrane (200 nm pore size, 60 μm thickness, 13 mm diameter, Anodisc 13, Whatman) as a template. In order to electrodeposit conducting polymer into each of pores of the membrane, one surface of the membrane must be converted in to an

electrode. This was accomplished by sputtering a Pt layer (400 nm) onto one face of the membrane. Silver paste (DOTITE D-500, Fujikura Kasei Co. Ltd.) was used to attach a platinum lead (0.4 mm ϕ) to sputtered Pt layer of the membrane. The membrane / Pt layer was used as a working electrode and only a 0.78 cm^2 area of the membrane was left exposed, and other parts were insulated by epoxy resin (S-40 B8 270 Ps, TAIYO INK MFG. Co. Ltd.).

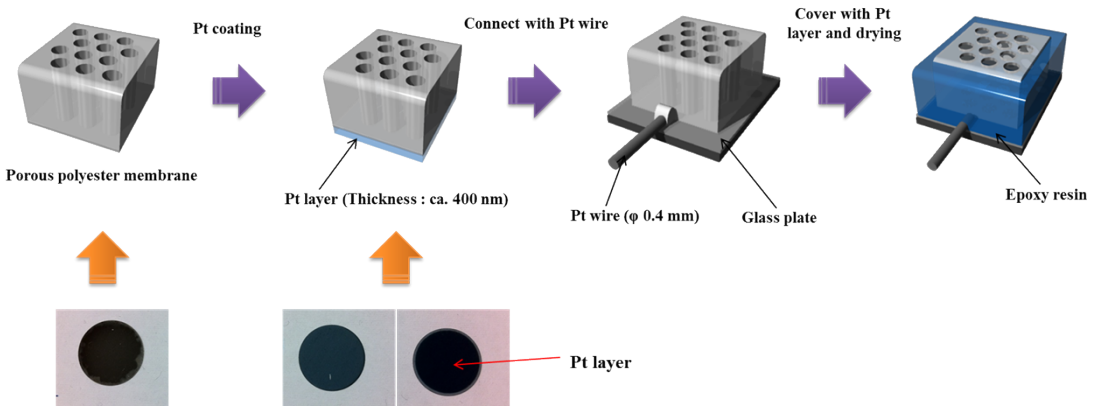

Figure S1 Procedure for preparation of template electrode.

4. Templated electrochemical polymerization of EDOT emulsion nanodroplets

Before templated electrochemical polymerization of EDOT emulsion nanodroplets, the template electrode was immersed in the electrolytic solution for several hours in order to replace air existed in nanopores of the template with electrolytic solution. The polymerization was carried out by a constant potential method under the following electrolytic conditions: working electrode, template electrode; counter electrode; platinum plate (2 x 2 cm^2); reference electrode, saturated calomel electrode (SCE); electrochemical cell, undivided glass beaker cell; temperature, 25±2 ^oC; applied potential, +1.4 V *vs.* SCE; EDOT monomer, 0.5 mmol; electrolytes, 1.0 M lithium perchlorate in water (25 mL). The electrochemical polymerization was also carried out in an acetonitrile solution at 25±2 ^oC under the same electrolytic conditions.

5. Scanning electron microscopy (SEM)

After the electrochemical polymerization, the alumina template was removed in 1.0 M NaOH aqueous solution, and the sample was rinsed in H_2O and dried under reduced pressure. Then, the sample was subjected to scanning electron microscopy (SEM) (VE-8800, Keyence Co.). The accelerating voltage of SEM was 15 kV.