Supporting Information

Enhanced durability of gold-coated current collectors for high power electrochemical devices

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Experimental Procedure

2.1. Au Electrodeposition on PCB current collector

Au was electrodeposited on the PCB electrode in aqueous electrolytes containing 4 g/L KAu(CN)₂ in KG120 (commercial gold electrodeposition bath, Poongwon Chemical Co., LTD). The PCB electrodes as substrates are composed of polyimide and Cu layers. Pretreatment of the Cu surface on the PCB substrate was performed according to the following steps: (1) first, the surface was degreased with acetone; (2) second, the surface was degreased by cathodic cleaning at 5 mA/cm² for 180 s in 35 g/L NaOH and 25 g/L Na₂CO₃; (3) followed by anodic cleaning at 5 mA/cm² for 30 s in 35 g/L NaOH and 25 g/L Na₂CO₃; (4) it was then neutralized in a 10 wt% H₂SO₄ solution for 30 s; and (5) rinsed with DI water. An electrochemical cell with a working PCB substrate electrode, a platinum counter electrode, and a saturated calomel reference electrode (SCE, 0.241 V vs. SHE) was used for electrodeposition in solution heated at 65 °C. Au electrodeposition on the PCB substrate was conducted using a constant current with agitation of the electrolyte solution by a magnetic stirrer at 100 rpm. The electrodeposition tests of Au were performed with different current densities by passing the same amount of charge density (0.5 C/cm²). All of the experiments were performed at an ambient temperature (22 ± 2 °C). To increase the nucleation rate and to
densify the Au layer, pulse electrodeposition was performed by periodically applying a high cathodic potential and pausing the application of the potential with a specific time ratio ($T_{on}$: 10 ms, $T_{off}$: 90 ms). The pulse electrodeposition was performed in a two-electrode system using the PCB substrate as a working electrode and a platinum counter electrode under the same electrolyte conditions.

### 2.2. Evaluation of the resistance of the Au coating layer

To investigate the corrosion resistance of the Au coating layer prepared under different electrodeposition conditions, anodic polarization tests were conducted in a 3 M methanol and 1 M H$_2$SO$_4$ solution at 25 °C. For the polarization test, the electrochemical cell consisted of a three-electrode system with a working electrode of an Au-coated PCB current collector, a platinum counter electrode, and a saturated calomel reference electrode. In addition, we evaluated the performance of direct methanol fuel cells by employing the optimized PCB current collector. The membrane electrode assembly (MEA) was placed between carbon papers and then installed in a single-cell test with bipolar plates. A 3 M methanol solution was supplied to the anode, and oxygen was supplied to the cathode. The cell power performance was performed at a constant voltage of 0.3 V.

### 2.3. Characterizations

The surface and cross-sectional morphologies of the Au-electrodeposited layers on the PCB current collectors were analyzed using scanning electron microscopy (SEM). The crystalline structures of the Au coating layers were examined by X-ray diffraction (XRD) analysis.