Electrodeposition of Continuous Ultrathin Layers of Nanoporous Metals on Glassy Carbon Electrodes

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Many catalytic processes utilize nanoscale materials in order to catalyze reactions such as methanol oxidation, formic acid oxidation, and oxygen reduction. The deposition of thin film catalysts is generally performed on metal electrodes such as Au or Pt electrodes, which contributes greatly to cost. For this reason, it is imperative to pursue a cost-effective approach that minimizes the amount of catalytic material required, which can be deposited or developed on a significantly less expensive substrate. Glassy carbon (GC) is a viable substrate for the deposition or fabrication of catalytic material due to its high conductivity, inertness toward most electrolytic solutions, and low cost. Currently, GC is a popular support for nanoparticles[1] (NPs) which are deposited directly onto the substrate after synthesis; there have also been attempts to prepare nanoscale catalysts directly onto GC itself.[2-4]

Nanoporous gold (NPG) is a unique material with applications to sensors and catalysis due to its high surface area-to-volume ratio.[5] In 2011, our group introduced an all electrochemical fabrication method of NPG functionalized with Pt in order to evaluate the ability of this catalyst to oxidize formic acid, which is one possible anode reaction in a fuel cell.[3] The NPG substrate for that project was fabricated on Au and GC electrodes, and the applied method generated nanoclusters of NPG when electrodeposited on GC as shown in Figure 1. Seeking to enhance the coalescence and continuity of NPG on GC, we employed the use of a Pd seed layer on GC and modified the electrodeposition method. These efforts resulted in the fabrication of a continuous layer of NPG on GC for the first time, significantly decreasing the cost of NPG fabrication for a variety of applications. Figure 2 verifies the continuity of the NPG layer electrodeposited on GC using the modified method. To further optimize this approach, we also explored another modification method for the GC substrate in order to improve adhesion between NPG and GC.

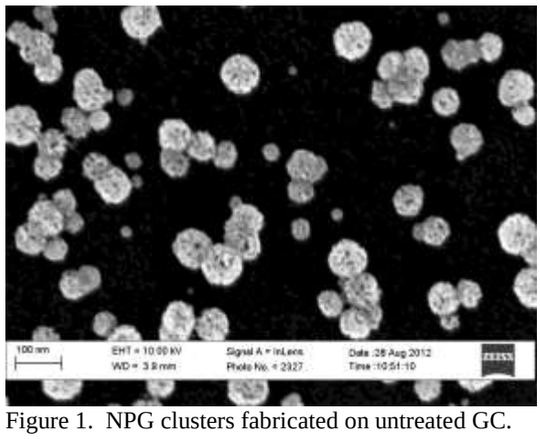

Figure 1. NPG clusters fabricated on untreated GC.

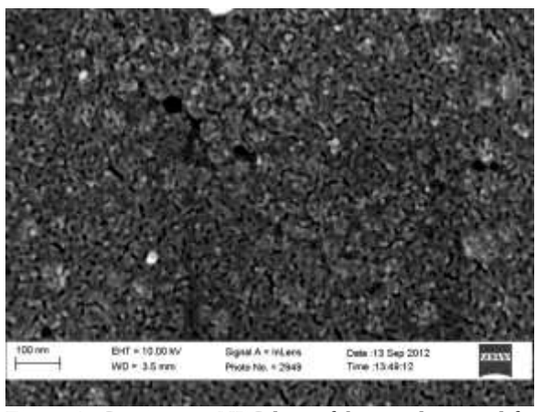

Figure 2. Continuous NPG layer fabricated on modified GC.

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