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Author: Ms. Simranjit Grewal
The National AeroSpace Training And Research Center (THE NASTAR CENTER), United States,
sgrewal7@ucmerced.edu

NOVEL FABRICATION OF GRAPHENE OXIDE SUPPORTED TIO2 CATALYST USING HTM AND ALD

Abstract

Fuel cells and metal air batteries involves oxygen reduction reactions (ORR), the performance-determining process. While Pt and its alloys are favorable due to higher catalytic activity, intense efforts to find alternatives is necessary as prohibit cost, limited availability and instability plague Pt peformance. In this presentation, we report a study of TiO2–graphene hybrid as a cost effective and more environmentally friendly alternative ORR catalyst. While TiO2 has not been considered an effective ORR electrocatalyst, a recent study by Pei and colleagues reported oxygen-deficient titanium dioxide rendered surprisingly competitive ORR activity and excellent durability[1]. Motivated by this and additional advantages of TiO2-x (abundance, safety and cost effectiveness) we probed the feasibility of applying self-doped TiO2-x based on graphene oxide (GO) to ORR catalyst. This hybrid structure leverages extremely high surface area and excellent electronic conductivity of reduced GO, which is highly advantageous for maximizing catalytically active sites per mass[2]. Since only the wrinkles and edges of GO are populated with active sites (binding functional groups), GO was treated with acid (HBr acid and/or oxalic acid) to functionalize the non-active sites (epoxide groups) on its basal plane. HBr acid is expected to create hydroxyl groups, and additional oxalic acid treatment is used to create carboxyl groups. These functional groups are then used to bind TiO2 nanoparticles[3]. TiO2/GO hybrid materials was synthesized by (HMT) hydrothermal reaction and ALD (Atomic Layer Deposition) using three different kinds of GO: as-synthesized, HBr-treated, and HBr + oxalic acid-treated GOs. For simplicity, we named the resulting hybrid materials as GT (GO-TiO2), HGT (HBr-treated GO-TiO2), and HOGT (HBr and oxalic acid-treated GO-TiO2), respectively. From a series of characterization, we found that HOGT samples show the best catalytic activity among the samples with a four electron process, whereas the other samples show a two-electron processes. It was also observed that HOGT showed the best performance when reacted at the highest temperature (160C) under HMT unlike the other samples. From these observations, it is concluded that high density of carboxyl group is essential in rendering high performance and durability toward ORR catalysts.

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References

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