Pt nanoparticles electrochemically deposited onto heteroatom-doped graphene supports as electrocatalysts for oxygen reduction reaction in acid media

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The combustion of fossil fuels contributes to worldwide climate change. One way to combat this is using proton exchange membrane fuel cells (PEMFCs), which emit water as the only product.[1] PEMFCs are of interest due to their ability to be used for both high- and low-energy needs and their ability to operate at low temperatures. The use of Pt catalyst in both the anode and cathode presents slight issues as the metal is costly and rare. Therefore, the entire system must be optimized to improve efficiency and cost-effectiveness, including the Pt and its support material.[2] However, very few systematic studies compare the effect that different heteroatom-doped graphene supports have on Pt nanoparticles' (PtNPs) electrocatalytic activity toward oxygen reduction rection (ORR).[3]

This study used six different commercially available heteroatom-doped graphenes (nitrogen, sulfur, phosphorus, boron, nitrogen-boron, and nitrogen-phosphorus) as a support material. The PtNPs were prepared using electrochemical deposition. The results were compared against PtNPs deposited on Vulcan XC-72R carbon following the same procedure. The PtNPs supported on different commercially available doped graphenes possessed varied half-wave potentials (Figure 1), electrochemically active surface areas, and specific activities (SA) for ORR. Thus confirming that the material used as a support affects the PtNPs electrocatalytic activity and reconfirming the need for a systematic study; of which this work provides. Most of the PtNPs supported on heteroatom-doped graphene showed SA values higher than that of Pt/C. The PtNPs supported on boron-doped graphene exhibited the highest specific activity ~45% higher than those supported on Vulcan XC-72R; the SA values at 0.9 V vs. RHE were 1.26 and 0.87 mA cm^{-2}, respectively.

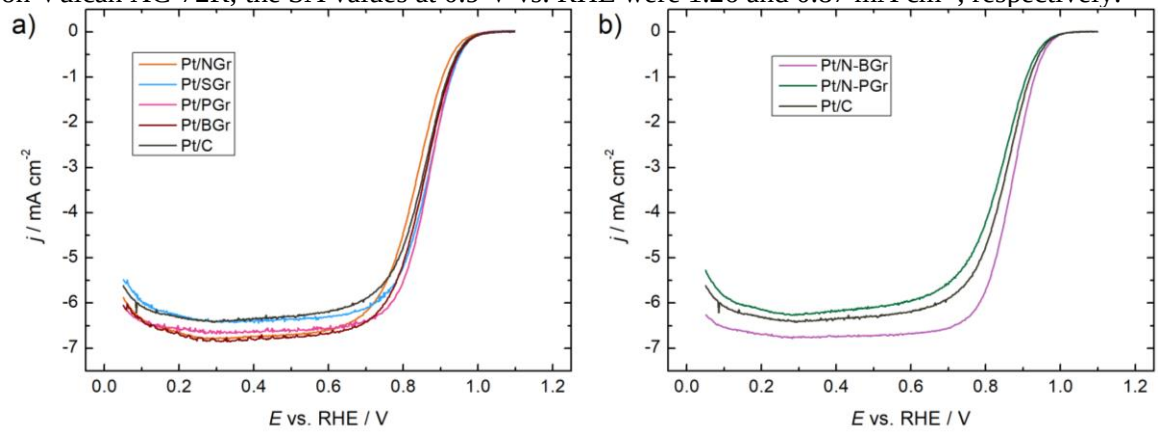

Figure 1. Comparison of ORR polarization curves for a) PtNPs supported on single heteroatom-doped graphenes and b) PtNPs supported on dual heteroatom-doped graphenes in O_2-saturated 0.1 M $HClO_4$ solution at 1900 rpm (v = 10 mV s^{-1}).

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References

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