

Trifunctional electrocatalytic properties of nitrogen doped graphitic carbon nanofibers synthesized on nichrome

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Introduction: Development of multifunctional electrocatalysts is significant for their promising application in energy storage, energy conversion and other electrochemical reactions. On this outlook, we report on the nitrogen doped carbon nanofibers (CNFs) exhibiting effective trifunctional electrocatalytic properties. We observed relatively good onset potential values for oxygen reduction reaction (ORR), oxygen evolution reaction (OER) and hydrogen evolution reaction (HER) for the synthesized electrocatalyst.

Experimental & Results: Nitrogen doped CNFs were synthesized in an atmospheric pressure chemical vapor deposition (APCVD) system on a nichrome foil.¹ Incorporation of metal particles was observed in the synthesized nitrogen doped CNFs, which also contributed to the trifunctional electrocatalytic properties. The resultant CNFs (4 mg) were then added to a mixture of deionized water and ethanol in the volume ratio of 3:1 along with 35 μ L of 5% Nafion™ dispersion solution. This ink was sonicated and dropcasted on a 3 mm glassy carbon (GC) electrode and allowed to dry overnight. The electrochemical analyses were performed using Autolab PGSTAT128N potentiostat and PINE research instrumentation rotating disk electrode (RDE) in a 3-electrode system with Ag/AgCl as the reference electrode. The ORR and OER analyses were performed in an O₂ saturated 0.1M KOH electrolyte while the HER analysis was performed in an N₂ saturated 0.5M H₂SO₄ electrolyte. Figure 1(a) shows the cyclic voltammogram (CV) for the synthesized catalyst, presenting the OER and ORR along with nickel oxidation-reduction peaks. The onset potential for OER was observed at 1.6 V, while that for ORR was seen at 0.74 V. Figure 1(b) shows the CV for ORR, presenting that the ORR is sluggish in N₂ saturated electrolyte as compared to the O₂ saturated electrolyte. Figure 1(c) shows the CV for HER of the catalyst in 0.5M H₂SO₄ solution, presenting good hydrogen evolution with an onset potential of -0.62 V.

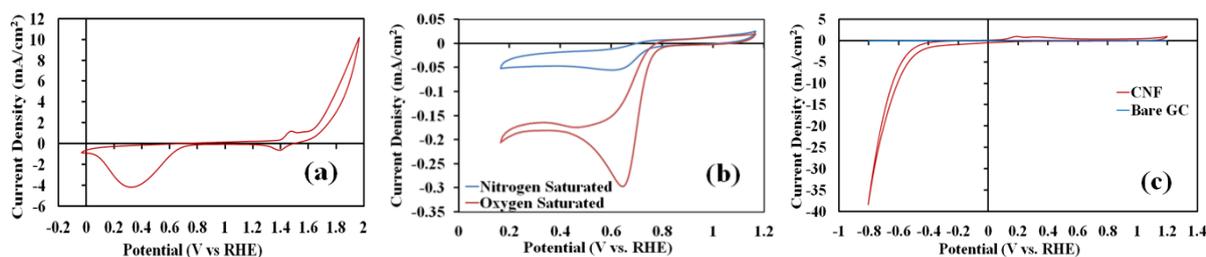


Figure 1(a). CV for the synthesized CNFs in O₂ saturated 0.1M KOH electrolyte, presenting the OER and ORR. **(b).** CV of ORR in N₂ and O₂ saturated 0.1M KOH electrolyte. **(c).** CV for HER of bare GC and CNFs sample in N₂ saturated 0.5M H₂SO₄ electrolyte. All analyses were performed at a scan rate of 50mV/s.

References

- (1) Vishwakarma, R.; Shinde, S. M.; Rosmi, M. S.; Takahashi, C.; Papon, R.; Mahyavanshi, R. D.; Ishii, Y.; Kawasaki, S.; Kalita, G.; Tanemura, M., *Nanotechnology* **2016**, 27 (36), 365602.