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Fish Scales Derived Activated Carbon as Cathode Electrocatalyst for Proton Exchange Membrane (PEM) Fuel Cells

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Proton exchange membrane (PEM) fuel cells are considered as alternative to internal combustion (IC) engines. However, high cost and low durability are the major challenges hindering their commercialization. As the platinum-based catalysts used conventionally in PEM fuel cell contribute about 33% of the total cost, last decade has witnessed considerable research focused on platinum free catalysts, especially for oxygen reduction reaction (ORR) at cathode. Activated carbon doped with heteroatoms (N, S, P, etc.) form one of the promising class of platinum free catalysts. Such doped carbons may be synthesized by using various natural and synthetic precursors. Among these, biomass derived carbons are promising owing to their unique structure, high heteroatom content, low cost and accessibility [1-3]. In this study, nitrogen-doped porous carbons (CN_x) derived by pyrolysis of fish scales (FS) of Rohu (Labeo rohita) fish (Figure 1) at different temperatures (300, 500, 700, 900 and 1100 °C) have been studied for their ORR electrocatalytic performance. Finally, CN_x is activated at 850 °C to increase surface area.

Figure 1: Optical image of as-received fish scales (FS) of Rohu fish before pyrolysis

The derived CN_x samples have been studied for their structural characteristics such as crystallinity, surface morphology, elemental composition, surface area, etc. Finally, ORR electrocatalytic performances of the CN_x samples are evaluated by using cyclic voltammetry and rotating disc electrode (RDE) linear sweep voltammetry (LSV) techniques. CN_x synthesized at high pyrolysis temperatures (≥800 °C) exhibit ORR electrocatalytic performance superior to that of platinum disc electrode (Figure 2).

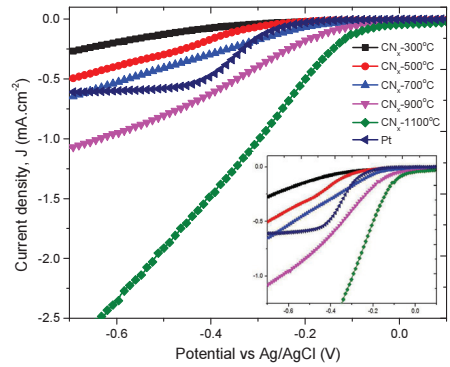

Figure 2: LSV curves of CN_x electrocatalysts (RDE) in O_2 saturated 0.1 M KOH at a scan rate of 10 $mV.s^{-1}$ and a rotation rate of 1600 rpm. For comparison, LSV curve for a Pt disc electrode (2 mm diameter) obtained under similar conditions is also provided

Owing to their high ORR activity, the FS derived activated carbons have significant potential towards their application as PEM fuel cell cathode catalyst layers.

References

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