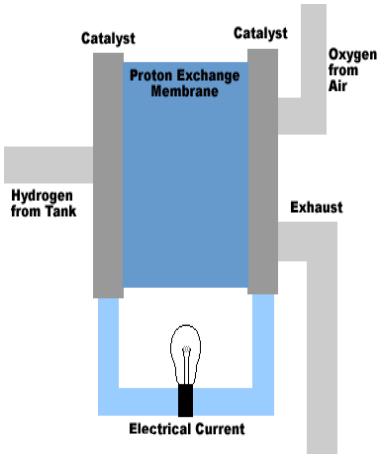
Technology for Low Cost Polymer Electrolyte Membrane (PEM) Fuel Cell:

As we know, fuel cells convert chemical energy into electricity through a chemical reaction of positively charged hydrogen ions with oxygen. These are different from batteries. In a fuel cell, a continuous source of fuel and oxygen or air is required to sustain the chemical reaction whereas in a battery the stored chemicals react with each other to generate electricity. Fuel cells can produce electricity continuously for as long as these inputs are supplied whereas battery needs to be charged or replaced once the reactants have completely reacted.

Though there are many types of fuel cells based on the electrolyte and operation temperature, a typical polymer electrolyte membrane fuel cell (PEMFC) comprises of an anode, cathode and an electrolyte (a polymer membrane) that allows positively charged hydrogen ions (or protons) to move between the electrodes of the fuel cell. Both the anode and cathode contains electrocatalyst in which the anode catalyst causes the fuel to undergo oxidation reaction that generates positively charged ions and electrons. Similarly, the cathode catalyst helps to reduce oxygen molecules in presence of proton and electrons to produce water. In a PEMFC normally platinum nanoparticles supported on conducting carbon (Pt/C) is used as the electrocatalyst, but it has high cost and limited availability in earth crust. Since oxygen reduction reaction (ORR) is kinetically sluggish at lower temperature, more platinum is required in the cell and this leads to high cost of the fuel cells. Development of cheap electrocatalysts for ORR is a solution to cut down the overall device cost.

At CSIR-NCL, a team led by Dr Sreekumar Kurungot is looking for the new generation of low cost Pt-free electrode materials with higher catalytic activity. For this, they prepared some metal-free carbon as well as non-precious transition metal based electrocatalysts for ORR. They synthesized different material like nitrogen doped carbon nanohorns, iron encapsulated carbon nanotube, nitrogen doped graphene, nitrogen doped porous graphene, etc. using different synthesis strategies. Most of these carbon catalysts are highly stable in alkaline and acidic environment and are generally free from the fuel poison. Apart from the catalysts development, the group is actively working on the demonstration of suitability of such materials in device level. The iron encapsulated carbon nanotube based cathode delivered a maximum power density of 200 mW cm^{-2} using Nafion as the proton conducting membrane. The mentioned power density is comparable or higher than some of the recent reports on non-Pt based fuel cell performance. The optimization of fuel cell based on non-Pt catalyst to achieve higher cell performance is an active research in the group.



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