

Mn based NPM catalyst for oxygen reduction reaction in acidic medium for PEMFCs

Karthikayini M.P, Kothandaraman R.*

Department of Chemistry, Indian Institute of Technology Madras, Chennai-600 036, Tamilnadu, India

E-mail : rkraman@iitm.ac.in

With the fast depletion of non-renewable resources, we are bound to look for replacements for our increasing energy requirements. PEMFCs are the most viable candidates with high power density, portability and low operation temperatures. Till date, state of the art catalysts for PEMFCs are expensive Pt based catalysts for both anode and cathode, which partly hinder the widespread use of fuel cell. Mn based catalyst has been successfully demonstrated towards ORR in basic medium [1], to our knowledge this is the first report where Mn based non-precious metal (NPM) catalyst is shown to work in acidic medium. One part of the scientific community believes in metal being part of active site, we corroborate this hypothesis enhancing the ORR overpotential while ligating the metal centers of NPM catalyst with bipyridine or EDTA ligand in acidic medium. We also observed a pH dependent overpotential raise while using EDTA, confirming metal site, which is part of ORR active site, being captured by EDTA to a greater extent as we increase the pH. In this study, a NPM catalyst is prepared using simple and cost effective synthetic route using Manganese, melamine and high surface area Ketjenblack Carbon via high pressure pyrolysis route [2]. From our initial studies it is observed that NPM catalyst with 3 wt.% Mn loading is highly selective towards oxygen reduction, with less than 2% peroxide production.

This study aims at

- (i) identifying the optimum metal and nitrogen loading
- (ii) identifying optimum pyrolysis temperature
- (iii) Nickel doping study for stabilizing Mn(III)/Mn(IV) redox couple, which may lead to higher longevity of NPM catalyst.
- (iv) providing proof of metal being part of active site in acidic medium via a pH dependent ORR overpotential measurement while using EDTA as complexing agent.

Fig. 1 shows the increase in ORR overpotential of catalyst while using 10 mM of bipyridine or EDTA in 1N H₂SO₄ at 60°C.

Fig. 1 LSV recorded in oxygen saturated 1 N H₂SO₄ at 60°C, 1600 rpm, 20 mV s⁻¹

References

- [1]. I. Roche, E. Chainet, M. Chatnet and J. Vondrak, *J. Phys. Chem. C* **111** (2007) 1434-43
- [2]. R. Kothandaraman, V. Nallathambi, K. Artyushkova, *Appl. Catal. B-Environ.*, **92**, (2009) 209-216.

