

## Improved catalytic activity of carbon-supported Co-phthalocyanine for oxygen reduction reaction modified with pyridine as nitrogen precursor

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Alkaline PEFCs exhibit several advantages over acid PEFCs including: the oxygen reduction reaction (ORR) is faster under alkaline conditions than in acidic conditions therefore providing lower activation losses, increased number of cheap materials for cell components due to less corrosive environment.<sup>1</sup> For obtaining the high catalytic performances, platinum (Pt) supported on carbon black is normally used as the best electrocatalyst. However, the high cost and limited availability of the Pt have been identified as the major barrier.<sup>2</sup> As a typical candidate, Metal-N<sub>4</sub> macrocycles are considered to be the most promising catalyst for alternative Pt for the ORR in fuel cell technologies. As yet, the electrocatalytic activity and stability of the macrocycle catalysts are still need to be greatly improved<sup>3</sup> for their lower ORR activity than that of Pt-based catalysts.<sup>4,5</sup>

In this paper, the carbon-supported non-precious metal (cobalt) catalysts, namely Py-CoPc/C has been proposed, where Py is the pyridine and Pc is the phthalocyanine. Py-CoPc/C catalysts were prepared by depositing CoPc and Py mixture on carbon black in a mortar, milling by adding 10 ml methanol for about 2h. Next, catalyst was dried at 40°C for 1h. 40 wt% CoPc + Py mixed with 60 wt% Vulcan carbon was tested, which is compared to commercial pure CoPc/C. The kinetics and electrocatalytic activity on the Py-CoPc/C catalysts have been measured using cyclic voltammetry (CV), linear sweep voltammetry (LSV) and rotating disk electrode (RDE).

Figure 1(a) shows the LSVs of the CoPc/C catalyst samples with different CoPc loadings under O<sub>2</sub> atmospheres in 0.1 M KOH solution at room temperature. It can be seen that 40 wt% CoPc loading gives the best ORR activity, below or higher

than this value are lower active for ORR. Too low loading cannot provide the enough active sites for oxygen reduction reaction, while too high loading may lead to catalyst aggregation, thus the decreased active area for oxygen reduction reaction. From Fig. 1(b), it can be seen that addition of Py as N-precursor can improve the catalytic activity of CoPc/C greatly and the optimal content of Py is 20 wt%, under which the onset potential and half-wave potential of 20%Py20%CoPc/C catalysts are about 0.2 V and -0.03 V, respectively. Further increasing the Py loading to 30%, the catalytic activity of Py-CoPc/C for the ORR falls dramatically due to loss of content of central metal Co. Similar results are obtained when increasing the total catalyst loadings (Py + CpPc) (Fig. 1c). The details will be reported in the meeting.

### References

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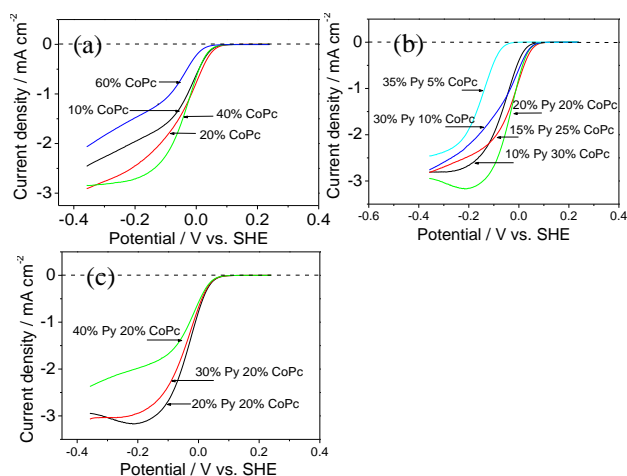


Figure 1: Polarization curves of (a) CoPc/C catalysts with various CoPc loadings, (b) Py-CoPc/C catalysts with various Py loadings, and (c) Py-CoPc/C catalysts with various total loadings in an O<sub>2</sub>-saturated 0.1 M KOH solution. Scan rate: 5mV/s. Electrode rotation rate: 1500 rpm.