

Metal-free and Transition Metal Chelated Porphyrin Framework for Methanol Oxidation

Alan Christian Lim, Harsharaj Jadhav, Gaurav Thorat, Jeong Gil Seo*

Department of Energy Science and Technology, Myongji University, Yongin City, Republic of Korea

*E-mail: jgseo@mju.ac.kr

Energy is harvested through the combustion of fossil fuel for the past few decades and still has been heavily depended on it until this very moment. Although energy has been efficiently supplied through this method, many of its downside has been recently addressed to mitigate its negative effects that contributes to the climate change due to the by-products released by burning fossil fuels. Moreover, its abundance has drastically decreased due to the high energy demand which requires for an alternative method to produce energy with greener technologies. One of the most attractive technologies, especially for transportation vehicles and portable devices, that is being highly considered is called the methanol oxidation or Direct Methanol Fuel Cell (DMFC) [1-2]. Apart from the absence of most of the toxic by-products obtained from combustion of fossil fuel, methanol oxidation can provide energy at a low operating temperature with cheap and environmentally benign materials. Its large-scale application has been impeded by the cause of the catalyst which requires Pt as the active material [3]. Thus, recent studies have been exploring transition metal containing catalyst as electrocatalyst [4].

In this study, a conjugated microporous polymer (CMP), composed of metal-free or transition metal chelated porphyrin monomers, was synthesized through Suzuki-cross coupling reaction and was applied as an active electrocatalyst for methanol oxidation. Interestingly, although transition metal-chelated CMPs showed good performance, the current density of samples increases as the amount of metalation decreases. As a result, metal-free electrocatalyst showed the highest activity. This could be attributed to the

presence of nitrogen atoms that is inherent within the porphyrin ring. A recent study has shown that different types of nitrogen atoms (graphitic, pyrrolic, pyridinic) on a nitrogen-doped carbon material essentially serves as the active site of an electron transferring mechanism type of a reaction [5]. Although the exact mechanism is still yet to be established, similar concept could be applied to explain the performance of metal-free porphyrin catalyst in methanol oxidation reaction.

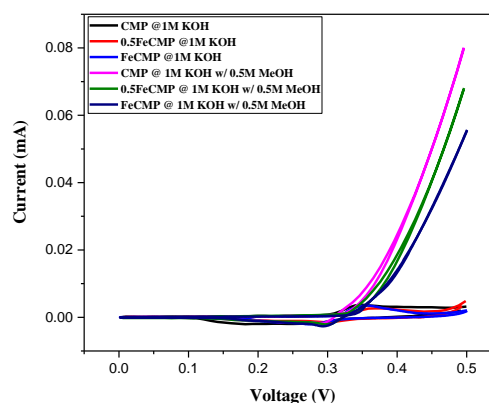


Fig.1 Cyclic voltammetric curves in 1M KOH in the presence and absence of 0.5M KOH under 10mV scan rate.

REFERENCES

- [1] T. Iwasita, *Electrochim. Acta*, 2002, 47, 3663-3674
- [2] E. Antolini, J.R.C. Salgado, E.R. Gonzalez, *App. Cat. B Env.* 2006, 22, 137-149
- [3] W.J. Huang, H.T. Wang, J.G. Zhou, J. Wang, P. Duchesne, D. Muir & et. al. *Nat. Comm.* 2015, 6, 1-8.
- [4] M. Bowker, E.K. Gibson, I.P. Silverwood, C. Brookes, *Faraday Discuss.* 2016, 188, 387-398
- [5] O.K. Kim, Y.H. Cho, D.Y. Chung, M.J. Kim, J.M. Yoo, J.E. Park, H. Choe, Y.E. Sung, *Sci. Rep.* 2015, 5, 1-7.