A JOURNEY FOR THE DEVELOPMENT OF A HIGHLY ACTIVE PtCe-C(Cr_3C_2) CATALYST: MATERIAL SELECTIONS, SYNTHESIS OPTIMIZATION AND ELECTRICAL MEASUREMENTS FOR METHANOL OXIDATION AND OXYGEN REDUCTION

Huy Quí Vinh Nguyen[1], Jaak Nerut[1], Heili Kasuk[1], Thomas Thomberg[1], Meelis Härmas[1], Riinu Härmas[1], Miriam Koppel[1], Patrick Teppor[1], Marian Külaviir[2], Jaan Aruväli[2], Olgo Volobujeva[3], Enn Lust[1]

[1]*Institute of Chemistry, University of Tartu, Ravila 14a, 50411 Tartu, Estonia*
[2]*Institute of Ecology and Earth Science, University of Tartu, Ravila 14a, 50411, Tartu, Estonia*
[3]*Institute of Materials and Environmental Technology, Tallinn University of Technology, Ehitajate Tee 5, 19086, Tallinn, Estonia*

e-mail of presenting author: vinh.nguyen@ut.ee

Various Pt-based catalysts coupled with other metals/metal oxides [1–3] have been studied to obtain economic anode catalysts for low-temperature fuel cells. CeO_2 is used for this study because the abundance of cerium is high and CeO_2 exhibits good synergistic effects coupled with Pt.

This study aimed to synthesize the highly active PtCeO_2-C catalysts towards methanol oxidation (MOR) and oxygen reduction (ORR) supported on Ketjenblack carbon, C(KB), and chromium carbide-derived carbon, C(Cr_3C_2), [4]. XRD and Raman confirmed the Pt and CeO_2 phases in the materials. The Pt content was around 16 wt%, and the crystallite sizes of Pt and CeO_2 were around 1 nm. The electrochemically active surface area of Pt nanoparticles was higher (54-89 m_{Pt}^2 g_{Pt}^{-1}) compared to previous study [5]. The mass activity (147 A g_{Pt}^{-1} at 0.85 V vs RHE) of MOR for PtCe-C(Cr_3C_2) after 60 minutes was higher than that (100 A g_{Pt}^{-1}) for PtCe-C(KB) in the mixture of 0.5 mol dm^{-3} H_2SO_4 and 1 mol dm^{-3} CH_3OH. The mass activity for both PtCe-C(Cr_3C_2 and KB) materials for ORR at 0.9 V vs RHE in 0.1 mol dm^{-3} $HClO_4$ were similar (approximately 304 A g_{Pt}^{-1}). The PtCe catalysts on C(Cr_3C_2) are suitable for MOR.

References

1. D. Chen, Y. Zhao, X. Peng, X. Wang, W. Hu, C. Jing, S. Tian, and J. Tian, *Electrochim. Acta* **177**, 86 (2015).
2. M. Amani, M. Kazemeini, M. Hamedanian, H. Pahlavanzadeh, and H. Gharibi, *Mater. Res. Bull.* **68**, 166 (2015).
3. Z. Cai, Z. Lu, Y. Bi, Y. Li, Y. Kuang, and X. Sun, *Chem. Comm.* **52**, 3903 (2016).
4. H. Q. V. Nguyen, J. Nerut, H. Kasuk, V. Grozovski, T. Thomberg, I. Tallo, R. Palm, M. Koppel, T. Romann, R. Härmas, J. Aruväli, M. Külaviir, and E. Lust, *Russ. J. Electrochem.* **58**, 781 (2022).
5. H. Q. V. Nguyen, J. Nerut, H. Kasuk, M. Härmas, P. Valk, T. Romann, M. Koppel, P. Teppor, J. Aruväli, O. Korjus, O. Volobujeva, and E. Lust, *J. Solid State Electrochem.* **27**, 313 (2023).

Euroopa Liit
Euroopa
Regionaalarengu Fond

Eesti
tuleviku heaks