TEMPLATED TRANSITION METAL-DOPED MESOPOROUS NANOCARBON CATALYST FOR ANION-EXCHANGE MEMBRANE FUEL CELL APPLICATION

Kaarel Kisand,[1] Ave Sarapuu,[1] John C. Douglin,[4] Arvo Kikas,[2] Alexey Treshchalov,[2] Maike Käärik,[1] Helle-Mai Piirsoo,[2] Päärn Paiste,[3] Jaan Aruväli,[3] Vambola Kisand,[2] Jaan Leis,[1] Aile Tamm,[2] Dario R. Dekel,[4,5] Kaido Tammeveski[1]

[1]*Institute of Chemistry, University of Tartu, Ravila 14a, 50411 Tartu, Estonia*

[2]*Institute of Physics, University of Tartu, W. Ostwald Str. 1, 50411 Tartu, Estonia*

[3]*Institute of Ecology and Earth Sciences, University of Tartu, Vanemuise 46, 51014 Tartu, Estonia*

[4] *The Wolfson Department of Chemical Engineering, Technion─Israel Institute of Technology, 3200003 Haifa, Israel*

[5] *The Nancy & Stephen Grand Technion Energy Program (GTEP), Technion –Israel Institute of Technology, 3200003, Haifa, Israel*

e-mail of presenting author: kaarel.kisand@ut.ee

Metal–nitrogen–carbon (M–N–C) catalysts containing transition metals in the form of single metal atoms coordinated to nitrogen have been investigated as low-cost alternatives to Pt-based oxygen reduction reaction (ORR) electrocatalysts. In addition to active sites, the catalyst support material structure is also of significant importance, because the support material should form porous channels that provide pathways for mass transfer. Synthetic approaches that create mesoporous structures via templating methods are often employed to provide sufficient mesoporosity. Nanocasting is the most popular method, which is accomplished by sacrificial templates made of silica. The template is removed after calcination, leaving an ordered nanocarbon network. However, removal of the template necessitates the use of dangerous corrosive chemicals, which is a significant barrier to scaling up the procedure. Sustainable alternatives to silica-based templates are easily removable inorganic particles such as MgO. These materials can be prepared by pyrolysis of a carbon precursor along with MgO or some thermally unstable magnesium compounds like acetate or citrate. These precursors decompose during the heat-treatment to form MgO nanoparticles, which can be dissolved in dilute HCl.

In this work, we present a simple MgO template-assisted method for synthesizing mesoporous nitrogen and transition metal co-doped carbon catalysts, where Honeyol™ serves as the carbon source and magnesium acetate as the template precursor.[1] The effect of the template on the catalyst material was studied using various methods including TEM, XRD and XPS. The ORR activity was explored by the RDE method and the best electrocatalysts were tested in an AEM fuel cell.

References

1. Kisand, K.; Sarapuu, A.; Douglin, J. C.; Kikas, A.; Treshchalov, A.; Käärik, M.; Piirsoo, H.-M.; Paiste, P.; Aruväli, J.; Leis, J.; Kisand, V.; Tamm, A.; Dekel, D. R.; Tammeveski, K. ACS Catalysis 2022, 12 (22), 14050–14061.

Euroopa Liit
Euroopa
Regionaalarengu Fond

Eesti
tuleviku heaks