Proceedings of the 8th World Congress on Recent Advances in Nanotechnology (RAN'23)
Lisbon, Portugal – March 23 – 25, 2023
DOI: 10.11159/icnnfc23.002

Ionomers and Electrocatalysts for Anion Exchange Membrane Fuel Cells

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Abstract

Anion exchange membrane fuel cells (AEMFCs) are very promising devices that allow the reduction or elimination of noble metal electrocatalysts due to the faster kinetics of the oxygen reduction reaction (ORR) in a basic environment. Anion exchange ionomers (AEIs) influence the morphology and the performance of the catalyst layer in the ORR. They act as binder of the catalyst particles, creating additional pathways for hydroxide transport between the reaction sites to the catalyst and to the anion exchange membranes (AEMs). The poor homogeneity of the catalyst layer is a deterring factor of the fuel cell performance and provokes aggregation and low utilization of the catalyst reducing the electrode mechanical stability. We recently synthesized AEIs with various backbones and architectures.[1-2] Backbones of different hydrophilicity were used: polysulfone, the most hydrophilic, poly(2,6-dimethyl-1,4-phenyleneoxide) with intermediate hydrophilicity, and poly(alkylene biphenyl) the most hydrophobic. The polymers were functionalized with trimethylammonium moieties grafted on long (LC) or short (SC) side chains.

Carbon quantum dots (CQDs) are interesting nanomaterials with tuneable band gap depending on the nature of the functionalizing groups. Given their easy synthesis, the absence of toxicity, and the semiconducting properties, CQDs were proposed as noble-metal free catalytic electrodes for the ORR. We have reported the advanced synthesis of CQD with average sizes in the nanometer range by pyrolysis, microwave irradiation and by hydrothermal treatment. [3] The content and position of N in the CQD can be tailored by functionalization with various nitrogen-containing compounds and the synthesis method and conditions. [4, 5] In this presentation we will provide an overview of composite electrocatalytic electrodes made from B-N, S-N, and Si-N co-doped CQDs and various AEIs for the ORR in alkaline solution.

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