UNIVERSITÄT DUISBURG ESSEN

IVG Institut für Verbrennung und Gasdynamik
Fakultät für Ingenieurwissenschaften

ZBT In cooperation with the ZBT GmbH

Master's project:

Influence of dispersion process and formulation composition on physico-chemical properties of electrocatalyst inks

Background:

Proton exchange membrane fuel cells (PEMFCs) are promising clean and sustainable energy sources for mobile, stationary, and portable applications. Although PEMFCs have reached a pre-commercial stage, their large-scale production is hindered. This is attributed to an elusive and empirically optimized catalyst ink formulation that results in poor utilization of materials and thereby increasing the production costs. During ink formulation (see Figure 1A), Pt particles supported on carbon (as active material) are dispersed in a colloidal suspension containing ionomer (a polymeric binder) and usually a mixture of solvents (so-called continuous phase) that govern physico-chemical properties such as aggregation, rheology, surface tension, and stability. Thus, there is a growing need for understanding the complex nanoscale interactions within the ink constituents and the interplay between these interactions and dispersion processes that may open an avenue for scalable manufacturing of fuel cells. In this project, the effects of dispersion method, solvent composition, ionomer and additives content on particle size, stability, rheological behavior and electrochemical performance will be systematically studied by means of analytical centrifugation (AC) (see Figure 1B), dynamic light scattering, electron microscope, rheometry and rotating disc electrode (RDE) technique. By establishing these process-structure and structure-property relationships, an economical and knowledge-based approach for the derivation of ink recipes will be developed that allows the generation of optimized fuel cell electrodes.

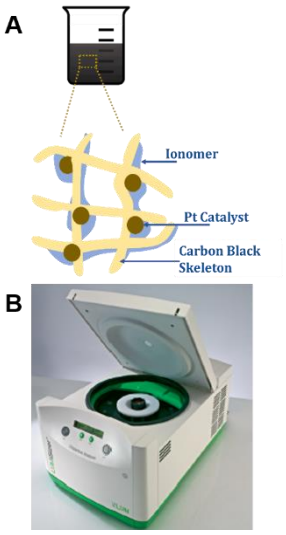

Figure 1:(A) Schematic of the ink chemistry. (B) Analytical centrifuge

Task description:

a) Investigate the effects of different dispersion techniques (ultrasonic bath, sonotrode, ultraturrax) on particle size, dispersion stability and electrochemical performance.
b) Examine colloidal behavior – aggregation, rheology at different solvent composition and additive content.
c) Study the influence of ionomer type and content on the structure and rheology of ink.

Requirements:

Studies in engineering sciences, materials science, or chemistry; interest / basic knowledge in colloid science and characterization of inorganic materials is beneficial. Electrocatalytic knowledge desirable Safe work practices, ability to take initiative and good interpersonal are expected.

Start: Immediately **Duration:** 6 months

Contact Person:

Shalmali Bapat, M.Sc.
ZBT, Room 240
Tel. 0203 379 – 3100
shalmali.bapat@uni-due.de

Dr. Fatih Özcan
ZBT, Room 240
Tel. 0203 379 – 3100
fatih.oezcan@uni-due.de

Dr. Ivan Radev
ZBT, Room 2203
Tel. 0203 7598 – 3312
i.radev@zbt.de

Dr. Edward Nürenberg
ZBT, Room 2410
Tel. 0203 7598 – 3126
e.nuerenberg@zbt.de