Catalyst layer fabrication study: modelling and experiment of dying process of catalyst ink droplet

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Our research work focuses on evaporation of catalyst ink droplet and its consequent skin formation pattern, which usually terms as coffee ring, with the background of optimization of catalyst layer fabrication, the key component of Proton exchange membrane fuel cells (PEMFC). PEMFC are promising clean energy converting devices with high efficiency and low to zero emissions. For commercialization of PEMFC, fabrication of catalyst layers (CLs) catalyst layer with low PT loading but high utility efficiency plays a significant role in reducing the PEMFC production cost while maintaining and further improving its efficiency. CLs fabrication can be generalized as deposition and evaporation of catalyst ink, which is a colloidal suspension solution composes of Carbon/Platinum particles, organic solvent, and ionomer, on a substrate. Our long term research objective is to get a comprehensive understanding of how the catalyst layers (CLs) would be formed when catalytic ink coated onto substrate, specifically interested in the macroscopic pattern formation under the coupling influence of internal flow and environmental effect. Though as the simplest possible starting point for CLs formation, dying process of colloidal suspension droplet is still quite challenging with interplaying influence among evaporation, diffusion, and Marangoni effects. We plan to establish a numerical model of predicting the skin formation of dried droplet, e.g. particle concentration, thickness, etc, based on experimental data acquired from this process, which aims to provide a strengthened guidance for CLs fabrication, thus produces custom-defined CLs, e.g. CLs with uniform thickness and desired C/Pt agglomerates distribution.