Mass Transfer to a Nanoelectrocatalyst

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Abstract

There are few mass transfer studies to nanocatalysts (1 nm [?] d_p [?] 100 nm). We have experimentally investigated the electrocatalytic reduction of hexacyanoferrate (III) to hexacyanoferrate (II) on gold nanospheres. The surface flux is insensitive to particle sizes of d_p[?] 30 nm. For particle sizes of $d_p < 30$ nm, the flux increases sharply with decreasing particle size. However, the measured fluxes are one to three orders of magnitude smaller than predicted by a purely diffusion-limited model. Using mathematical modeling, we evaluated six mechanisms potentially affecting mass transfer to a nanoparticle. Flux concentration due to the curvature effect and electromigration become important below 30 nm. Stabilizing layers on the particle also greatly influence the flux through electrosteric effects. Brownian advection, enhanced surface reactivity, and particle aggregation play negligible roles. Tuning the charge and the tortuosity of the stabilizer layer to potentiate the flux may be useful in nanosuspensions.

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