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## Meso-Structured Polymer Electrolyte Fuel Cell Electrode

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### Abstract

Increasing the utilization of Pt and Pt alloy catalysts in polymer electrolyte fuel cell cathodes is critical to improving the high power density operation, particularly at low Pt loadings. State of the art electrodes are fabricated in an ink deposition process that leads to uncontrolled electrode architecture with random aggregates of functional domains (catalyst, ionomer, and pore volume) (1). The randomness in the domains induces high tortuosity transport pathways for ions and fluids, which cause severe transport resistance during high current density operation. Thin ionomer films cause additional transport resistance and poisoning of the Pt catalyst, which becomes more significant at low Pt loadings. Reducing the amount of ionomer in the catalyst domain without affecting the ionic transport resistance is key to improving the utilization of the Pt and reducing the transport resistance at low Pt loading.

Rational design of the electrode structure with controlled low tortuous ionic transport pathways could improve performance. The introduction of the ionomer pathways could also enable reduction of the ionomer volume in the catalyst domain, reducing the transport resistance. Middelman et al. proposed electrode structures consisting of aligned components in a low tortuosity configuration to improve performance (2). In this work, we present an alternative electrode structure based on a vertically aligned array of Nafion pillars in the cathode catalyst layer, as shown in Figure 1a. Figure 1b shows the SEM image of the Nafion pillars. Pt supported on carbon catalyst was deposited on the Nafion pillars to fabricate a meso-structured electrode. Nafion pillars provide high conductive and low tortuous pathways for protons, reducing the effective transport distance, and enabling reduction of the ionomer binder in the catalyst domain.

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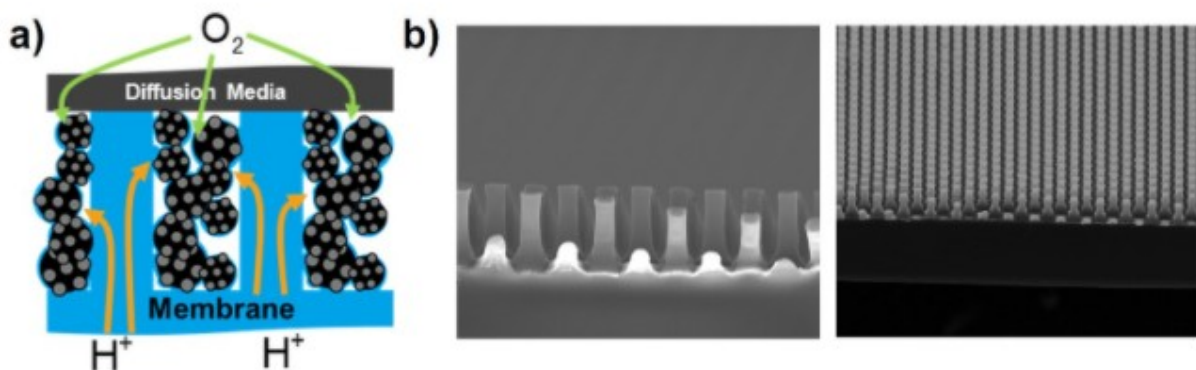


Figure 1. a) Schematic of the meso-structured electrode. b) SEM image of a cross-section of the Nafion pillars.

Figure 1