

## Improving MEA Kinetic Performance through Removing Nafion Ionomer Binders in a Catalyst Layer

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A typical MEA is a composite of a polymer electrolyte membrane that is sandwiched between two porous catalyst layers. The catalyst layer consists of a network of recast Nafion ionomer that holds carbon aggregates together. The precious metal catalyst nanoparticles are attached onto the surface of the carbon aggregates. These catalyst nanoparticles are covered by a thin Nafion ionomer and the oxygen reduction reaction (ORR) occurs at the interface of a Nafion thin film and the catalyst nanoparticle. Protons are transferred from the anode side, through the Nafion membrane and through Nafion ionomer network inside the catalyst layer, eventually arrive at the interface of Nafion thin film/catalyst nanoparticle to participate the ORR. Thus, to effectively have ORR been proceed, (1) a Nafion ionomer network is needed and (2) a thin Nafion film over the surface of catalyst nanoparticle is needed. However, the thin Nafion ionomer film constructs a diffusion barrier for oxygen. Kocha et al. work [1] revealed that mass activity of catalyst can be improved 300% if the Nafion ionomer thin film is removed.

We are taking a radical approach to overcome the diffusion barrier from Nafion ionomer. First, we remove the Nafion ionomer as binder (28%) from the catalyst layer and use low content PTFE (5%) as binder. Second, we use functionalized carbon black supported catalyst to provide proton conductivity inside the catalyst layer.  $-SO_3H$  functional groups were chemically grafted onto the surface of the aggregates of the carbon black particles and such functionalized carbon black was used as the Pt catalyst support to provide the proton conductivity in a catalyst

layer. Such a catalyst has achieved the 200% increase on proton conductivity as compared with normal carbon black supported Pt catalyst layer with the same amount of PTFE binder (seen Fig 1). We expect that such increase on proton conductivity can be translated into MEA performance and in particular, on the high current density performance. The fundamentals of the increase on ORR kinetic performance is currently studied using both RDE and MEA configuration. These results will be reported soon.

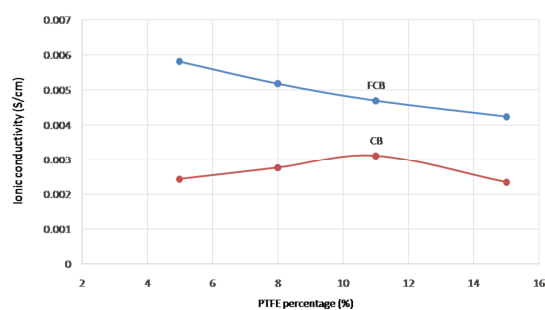


Figure 1. Ionic conductivity of catalyst layer using FCB/CB as catalyst supporters with different amounts of PTFE binder.

[1] Shyam S. Kocha, Jason W. Zack, Shaun M. Alia. Influence of Ink Composition on the Electrochemical Properties of Pt/C Electrocatalysts. ECS Transactions, 50 (2) 1475-1485 (2012)