Description: This abstract focuses on the development of more effective Alkaline Anion Exchange Membranes using Silver Nanoparticle deposition, which produced a higher power output in Hydrogen Fuel Cells. In our experiment, I was responsible for assisting in the deposition process of silver nanoparticles onto the membranes. This research was accepted into the Material Research Society Fall 2022 Conference, where our group presented in front of other researchers. Our abstract is located in the Official MRS Fall 2022 Conference Program PDF, which can be found at the following URL:
https://www.mrs.org/docs/default-source/meetings-events/fall-meetings/2022/f22-program-11-14-22.pdf?sfvrsn=648e020e_3

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Insight into the Synergy Between Silver Nanoparticles and Alkaline Anion Exchange Membranes for Power Output Konnie Duan[1], Quinton Geller[2], Helee Shukla[3], Haoyan Fang[4], Md Farabi Rahman[4], Aniket M. Raut[4], Sean Fang[5], Thomas Luong[6], Yuhao (Ben) Pan[7] and Miriam Rafailovich[4]; [1]Harvard-Westlake School, United States; [2]Los Alamos High School, United States; [3]New Hyde Park Memorial High School, United States; [4]Stony Brook University, The State University of New York, United States; [5]Maggie L. Walker Governor's School, United States; [6]Plano West Senior High School, United States; [7]Stuyvesant High School, United States

To develop innovative clean energy processes, scientists have been researching alkaline anion exchange membrane fuel cells (AEMFCs), which are currently expensive but can function in salt water and basic environments, unlike other hydrogen fuel cells. Previous studies on proton exchange membrane (PEM) fuel cells showed that monolayer sheets of nanoparticles (NPs) deposited onto Nafion PEMs via the Langmuir Blodgett Trough (LBT) were highly effective in increasing fuel cell power output. Density functional theory (DFT) calculations indicated the existence of a synergy between the surface of the Nafion membrane and the platelet shaped particles, which reduced the activation barrier for the CO oxidation reaction [1,2]. In AEMFCs, a different set of reactions determines the power generated, but a potential synergy between NPs and the membrane surface may still exist and lower the activation barrier. To explore this possibility, we evaluated silver (Ag) NPs, which have been shown to be effective in catalyzing these reactions [3]. We synthesized AgNPs using the Brust method and either deposited a monolayer using the LBT or sprayed AgNPs directly onto parts of the AEMFC. The AEMFCs were treated with dodecanethiol (C_{12})-protected AgNPs under five different conditions: (a) without AgC_{12} NPs, (b) with AgC_{12} NPs deposited using the LBT at 5 mN/m on both sides of the membrane, (c) with AgC_{12} NPs deposited using the LBT at 10 mN/m on both sides of the membrane, (d) with 1 µg/cm2 of AgC_{12} sprayed on both sides of the membrane, and (e) with 1 µg/cm2 of AgC_{12} sprayed on both electrodes. Each cell was tested for maximum power density. Approximately the same amount of AgNPs were applied via the LBT with the 10 mN/m surface pressure and each of the airbrush sprays.

Each cell was operated with 0.76 mg/cm^2 Pt/C electrodes in ambient conditions at 60°C.

The AEMFC with AgC_{12} NPs sprayed onto the membrane exhibited the highest maximum of 0.556 W/cm^2 (39.7% increase) compared to the other test conditions, which include 0.469 W/cm^2 (17.8% increase) for AgNPs sprayed onto the electrodes, and 0.380 W/cm^2 (4.52% decrease) and 0.451 W/cm^2 (13.3% increase) for the 5 mN/m and 10 mN/m surface pressure depositions, respectively. The control cell had a peak power density of 0.398 W/cm^2 when operated. The membrane spray may have worked better than the electrode spray because of a yet-uncharacterized synergistic effect between the AgNPs and the membrane. The shape of the AgNP may also play a role in the observed effect, as shown by the reduced catalytic activity of deposited AgNPs, which are platelet-shaped after LBT application. The AEMFC with the monolayer deposited at 10 mN/m had a slightly greater maximum power density compared to deposition at 5 mN/m, likely due to the increased quantity of AgNP catalysts. These results clearly demonstrate that a synergy is established when AgNPs are deposited on the membrane for AEMFCs as well. The mechanism of action in AEMFCs, which is most enhanced by sprayed AgNPs on the membrane, appears to be different from that of PEM fuel cells, which showed enhancement when NPs were applied via LBT in previously published work. DFT calculations are in progress in order to elucidate the difference in mechanism.

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