**Description:** This abstract focuses on the development of a cellulose-based renewable and cheap alternative to current industry Proton Exchange Membrane Hydrogen Fuel Cells (PEMFC). I was responsible for creating acid solutions and treating the cellulose membranes with these acids along with the flame retardant, RDP. The cellulose membranes were then tested for power output in a hydrogen fuel cell. I researched various improvements and potential modifications for the treatment process to increase power output. Currently, the methods for treating the Proton Exchange Membrane for Hydrogen Fuel Cells are patent pending, with grants from the US Navy. This research was also accepted into the Material Research Society Fall 2022 Conference, where our group presented this abstract to other researchers. Our abstract source 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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**Engineering Proton Exchange Membranes for Hydrogen Fuel Cells from Low Cost Micro Cellulose Filters** Yuhao (Ben) Pan[1], Thomas Luong[2], Sean Fang[3], Aniket M. Raut[4], Haoyan Fang[4], Md Farabi Rahman[4], Konnie Duan[5], Helee Shukla[6], Quinton Geller[7], David Sprouster[4], Rebecca Isseroff[4] and Miriam Rafailovich[4]; [1]Stuyvesant High School, United States; [2]Plano West Senior High School, United States; [3]Maggie L. Walker Governor's School, United States; [4]Stony Brook University, The State University of New York, United States; [5]Harvard-Westlake High School, United States; [6]New Hyde Park Memorial High School, United States; [7]Los Alamos High School, United States

Hydrogen fuel cells are an emerging form of green energy that can produce electricity from hydrogen and oxygen gas with the only by-product being water. However, the fuel cell component materials themselves may not be environmentally sustainable. Currently the material most commonly used for the electrolyte membrane is Nafion, which is a perfluorosulfonic acid polymer created by free radical copolymerization of a perfluorinated vinyl ether sulfonyl fluoride co-monomer with tetrafluoroethylene. This has multiple toxic components and hence is not environmentally sustainable. Cellulose has been proposed as an inexpensive renewable alternative material where both microcellulose [1] and nanocellulose [2] have demonstrated the ability to generate power when used as an electrolyte membrane on the fuel cell. However, nanocellulose requires a complex synthesis process where functionalization with strong acids is performed [2]. This research presents a more natural membrane by taking low-cost, bulk-produced commercial cellulose filter papers and treating them with weak acids and a few drops of Resorcinol bis(diphenyl phosphate) (RDP). A power output of approximately 12mW/cm2 was obtained from membrane electrode assemblies (MEAs) constructed from filter paper membranes soaked in solutions consisting of a single weak acid with added RDP drops, and operated in air at 60oC with 0.1mg /cm2 of Pt at the cathode and anode. This value compared favorably with that of an MEA constructed from nanocellulose produced via the nitro oxidation method and operated under similar conditions which generated 11mW/cm2. Treatment of the filter paper membrane to a combination of acids and RDP and incorporation into a similarly constructed MEA yielded a power output of 16mW/cm2 when operated under the same conditions. However, operation under O2 produced a power output of 35mW/cm2 which was significantly larger than the 19.1Mw/cm2 output reported for a nanocellulose membrane operated in O2. SEM/EDX analysis of the cellulose filter paper membranes shows a phosphate- rich membrane forming between the fibers which possibly explains the lack of hydrogen gas crossover, despite the porosity expected from filter paper construction. Micro-CT analysis of the filter paper membranes further confirms the absence of porosity throughout the entire membrane. Further solid state NMR, as well as XPS is in progress in order to understand the chemical synergy enabled by the combination of acids and RDP.

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