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Bacterial Cellulose Polymers for PEM Fuel Cells

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The utilization of cellulose-producing bacteria in decarbonizing hydrogen technologies, particularly for proton exchange membranes (PEMs) in fuel cells and electrolyzers, is an alternative for more sustainable hydrogen production. Numerous research institutions and universities have investigated the cultivation of these non-pathogenic, naturally occurring bacteria as eco-friendly substitute. Key bacteria have been extensively studied for their ability to produce bacterial cellulose (BC) with high purity, mechanical strength, and biocompatibility. These properties can be further optimized through
co-culturing with complementary microorganisms, potentially improving membrane performance metrics like proton conductivity and thermal stability.

Membrane fabrication will employ electrospinning to achieve precise control over nanofiber morphology, influenced by parameters such as solution viscosity, solvent and additive selection, applied voltage, flow rate, and ambient conditions like humidity and temperature. This method enables the creation of high surface area, tunable structures suitable for PEM applications.

To advance this study, a comprehensive database will be constructed, encompassing cultivation variables (pH, temperature, humidity) alongside electrospinning and post-processing data (fiber diameter, porosity, mechanical strength, biodegradation rate, among others). This repository will facilitate the analysis, including machine learning models for parameter optimization, predictive modelling of membrane performance, and identification of key influencing factors.

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