pressing sustainability concerns. Electrospun nanofiber fabrics offer excellent mechanical strength, elasticity, and durability while allowing the incorporation of functionalities like antimicrobial properties or UV protection. Biodegradable and renewable polymers such as polylactic acid, silk proteins, and cellulose are being used to produce bio-nanofibrous textiles through electrospinning. However, these bio-fiber textiles are mainly limited to specialized fields rather than regular clothing due to challenges like scalability, higher production costs, and complexity in multi-material processing.

Viewing through the lens of sustainable development goals (SDGs), overcoming these obstacles and commercializing electrospun textiles for everyday clothing presents a promising approach that can significantly contribute to nine of the seventeen goals, including SDG 6: Clean Water and Sanitation; SDG 9: Industry, Innovation, and Infrastructure; SDG 12: Responsible Consumption and Production; SDG 13: Climate Action; SDG 14: Life Below Water; and SDG 15: Life on Land. Finally, advancing electrospinning technology to overcome the current limitations holds the potential to transform the textile industry and address critical environmental and sustainability challenges aligned with these SDGs.

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Electrospun Microporous Layer with Gradient Wettability and Hierarchical Porous Structure for Enhanced PEMFC Performance

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Abstract. This study presents the development of an acetylene black and polyvinylpyrrolidone-based electrospun microporous layer (MPL) for proton exchange membrane fuel cells (PEMFCs), aimed at enhancing performance and sustainability. The novel MPL features a hierarchically porous structure and gradient wetting properties, enabling improved water retention and gas transport. Fabrication involved electrospinning, thermal treatment, and immersion in a polytetrafluoroethylene suspension. The MPL demonstrated a power density exceeding 1.0 W/cm² under varying humidity conditions, with minimal degradation after durability testing. This innovation offers potential for eliminating external humidification systems, contributing to more efficient and durable PEMFCs.

Keywords: PEMFC, MPL, Electrospinning, Composite fiber membrane.

As the world transitions to a low-carbon economy, hydrogen energy has emerged as a promising clean and efficient alternative to fossil fuels. Proton exchange membrane fuel cells (PEMFCs) are among the most promising technologies for achieving low-carbon energy goals due to their ability to generate electricity without harmful emissions. A critical component of PEMFCs, the microporous layer (MPL), plays a pivotal role in influencing cell performance. In this study, we developed an acetylene black and polyvinylpyrrolidone-based electrospun MPL, featuring a hierarchically porous structure in the plane of the membrane and a gradient wetting property across the membrane thickness. The fabrication process involved electrospinning, thermal treatment, and subsequent immersion in a polytetrafluoroethylene suspension, followed by drying and sintering. The resulting MPL exhibited combined hydrophilic and hydrophobic characteristics at the microstructural level, offering enhanced water retention and gas transport. Under relative humidity conditions ranging from 0 % to 100 %, the MPL achieved a power density exceeding 1.0 W/cm-2. After 100 cycles of square wave durability testing, the power density degradation remained below 10 %. This novel MPL design has the potential to replace external humidification systems in PEMFCs, thereby improving overall cell performance and durability.