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Transforming Electrospun Nanofibers into Wardrobes for Sustainable Fashion

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Abstract. *This paper explores the transformative impact of globalization on the textile industry, examining how advancements in nanotechnology and materials science present opportunities to address environmental and sustainability challenges. The global textile market, valued at over $689 billion, faces significant ecological concerns, including water degradation and textile waste generation. The study highlights electrospinning as a promising technique for developing advanced nanofibrous textiles with enhanced mechanical properties and functionalities, utilizing renewable and biodegradable polymers. Despite challenges like scalability and production costs, the commercialization of bio-nanofibrous textiles for everyday use aligns with multiple sustainable development goals (SDGs), including clean water, responsible consumption, and climate action. Addressing these barriers could revolutionize textile manufacturing, contributing to a more sustainable future.*

Keywords: *electrospinning; textile industry; sustainability; nanofiber.*

Globalization has transformed the textile industry by accelerating the global circulation of fashion trends and reshaping how textiles are produced and consumed worldwide. Today, the global textile market has skyrocketed to over $689 billion, driven by population growth, increased use of synthetic fibers, economic expansion in emerging markets, and supportive government initiatives. This exponential growth, however, comes with significant environmental impacts. The textile sector is the third-largest contributor to freshwater degradation, requiring approximately 2,700 liters of water to produce a single T-shirt and generating 92 million tonnes of textile waste annually. Alternative solutions like textile recycling involve hidden costs and challenges, making them insufficient approaches for transforming waste into affordable textiles. These issues underscore the urgent need for sustainable and innovative textile production strategies that effectively address waste generation and environmental costs.

Advancements in nanotechnology and materials science have positioned electrospinning as a promising solution that will enable the fabrication of advanced nanofibrous textiles with improved structural properties, potentially revolutionizing manufacturing and tackling 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.*