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Abstract	:	Direct methanol fuel cells (DMFCs) face challenges from methanol crossover and performance degradation caused by inefficient microporous layer (MPL) designs, where conventional carbon-based MPLs show limitations in surface coverage uniformity, catalyst utilization efficiency, and pore structure balance. To address these issues, this study developed an optimized MPL using carbon nanofiber-titanium dioxide (CNF-TiO₂) composites through parametric optimization of the fabrication process. Key variables included MPL loading density, CNF:TiO₂ mass ratio, Nafion binder concentration, and methanol feed concentration, which were analyzed via screening experiments and Response Surface Methodology (RSM) using a Central Composite Design (CCD). The optimization targeted three response metrics: power density (R1), open-circuit voltage (R2), and peak current density (R3). The results demonstrated that the modified CNF-TiO₂ microporous layer (MPL) exhibited a synergistic effect when optimized with the selected parameters. Initial screening experiments examined MPL loading, CNF-to-TiO₂ ratio, Nafion® content, and methanol concentration, revealing that the composition ratio, Nafion® content, and methanol concentration had significant impacts on the cell's performance responses. These key parameters were further explored using Response Surface Methodology (RSM). The optimized MPL exhibited improved..see more.