

# A Study on Functional Textile Surface Coatings via Plasma Polymerization

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## 플라즈마 중합을 이용한 섬유 표면 기능성 부여 연구

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### Abstract

Atmospheric pressure plasma polymerization offers a solvent-free, low-temperature alternative to wet finishing, enabling uniform coatings and roll-to-roll treatment. The method cuts water use by over 95%, removes solvent emissions, and improves durability such as adhesion and wash resistance. This scalable process supports sustainable, high-performance textiles.

## 1. Introduction

As environmental regulations become more stringent worldwide, the textile industry faces increasing pressure to adopt eco-friendly and high-efficiency processing technologies. Conventional wet finishing processes, which impart functional properties to textiles, consume large amounts of water and organic solvents, resulting in wastewater discharge, air pollution, and safety concerns from residual solvents. These challenges highlight the urgent need for sustainable alternatives that reduce environmental burden while maintaining durability and performance.

This study introduces atmospheric pressure plasma polymerization as a solvent-free, low-temperature technique for functional textile surface modification. By depositing and crosslinking functional monomer vapors, the method enables uniform and dense coatings that penetrate complex fiber and nonwoven structures. Unlike vacuum-based plasma systems, the atmospheric configuration supports continuous roll-to-roll processing, facilitating integration into existing industrial production lines.

The process achieves more than a 95% reduction in water

consumption, eliminates solvent emissions, and streamlines unit operations compared to conventional wet finishing. Coatings fabricated via plasma polymerization demonstrate strong adhesion, high washing fastness, and excellent abrasion resistance, ensuring reproducibility and long-term performance. Furthermore, selective incorporation of chemical functionalities provides versatile applications, such as hydrophobicity, stain resistance, wettability control, and improved interfacial bonding. Overall, this approach offers a sustainable and scalable pathway for developing high-value functional textiles while supporting the industry's transition toward environmentally responsible manufacturing.