Plasma Applications in Textile as a Sustainable Technology for Textile Material Processing

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Abstract

This paper explores the functional finishing of textile materials using the etching and deposition processes of low-temperature atmospheric pressure plasma technology. Traditional textile wet processing techniques are known to be chemical, water, and energy-intensive. Plasma processing offers an economical, green, and non-aqueous alternative that is gaining popularity for converting greige textile goods into finished products with enhanced comfort, appeal, and feel.

Plasma, often referred to as the fourth state of matter, involves activating gas atoms with energy to generate highly energetic electrons, protons, neutrons, and radicals. The bombardment of these particles leads to the cleavage of chemical covalent bonds, resulting in physico-chemical surface modification. The degree of modification depends on various plasma processing parameters, such as the power of plasma generation, exposure duration, and the type of gases used. In this study, we utilize atmospheric pressure, dielectric barrier discharge (DBD) cold plasma for the functional finishing of various textile materials, including cotton, silk, polyester, nylon, and polypropylene.

Our findings demonstrate significant performance improvements, such as enhanced color uptake, improved adhesion with polymer-coated fabrics, and the impartation of functionalities like hydrophilicity, hydrophobicity, antibacterial properties, antistatic capabilities, and electrical conductivity. This multifunctional finish exhibits superior wash durability compared to classical functional finishes.

We believe this research will be of great contribution in the field of smart sensor applications and sustainable textile processing.

Keywords

Surface Etching, Plasma enhanced chemical vapour deposition (PECVD), hydrophilicity, hydrophobicity, antibacterial, antistatic, Multifunctional, durable.