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Effects of Titanium Dioxide (TiO_2) Nanoparticles Deposition on The Physical and Comfort Properties of Meltblown Polypropylene Nonwoven Face Mask Materials

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Structured Abstract

Background: Meltblown polypropylene nonwoven fabrics are widely used as filter layers in medical and daily face masks due to their good filtration efficiency, lightweight structure and low cost. However, prolonged use of these masks often causes discomfort because of low breathability, heat buildup and moisture retention. These issues may reduce user comfort, especially in hot and humid environments. Recently, nanotechnology has been explored to improve the functional and comfort properties of face mask materials. Titanium dioxide (TiO_2) nanoparticles are known for their surface modification properties, which may help to enhance facemask performance. However, information on how TiO_2 coating affects the physical structure and comfort behaviour of meltblown polypropylene filter materials is still limited.

Methods: In this study, commercial 3-ply polypropylene face masks and laboratory prepared meltblown polypropylene nonwoven fabrics coated with 5% and 10% TiO_2 were used. Fabric weight and thickness were measured using standard textile testing methods. Surface morphology and elemental composition were analysed using scanning electron microscopy (SEM) and energy dispersive X-ray (EDX). Comfort related properties, including air permeability, water vapour permeability and moisture management behaviour, were evaluated using standard testing procedures.

Results: The results showed that fabric weight and thickness increased with increasing TiO_2 concentration. SEM images confirmed the successful deposition of TiO_2 particles on the fibre surfaces, while EDX analysis verified the presence of titanium on the coated samples. The TiO_2 coated fabrics showed higher air permeability compared to the commercial meltblown filter, indicating improved breathability. Water vapour permeability values were similar for all samples, suggesting that the TiO_2 coating did not significantly affect vapour transmission. Moisture management results showed low liquid transport for all samples due to the hydrophobic nature of polypropylene.

Conclusion: In conclusion, TiO_2 coating modified the physical structure of meltblown polypropylene nonwoven fabrics without damaging the fibre network. The 10% TiO_2 coated sample demonstrated the most promising balance between physical and comfort properties. This study shows that TiO_2 coated meltblown polypropylene nonwoven fabrics have potential to be used as face mask filter layers with acceptable comfort behaviour.

Keywords: Face mask, titanium dioxide, meltblown polypropylene, morphology, comfort properties

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