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DEVELOPMENT OF COATINGS FOR NONWOVEN GARMENTS TO PROVIDE BOTH REASONABLE COMFORT AND PROTECTION AGAINST BLOODBORNE PATHOGENS

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Abstract

A microporous polyvinylidene fluoride film sandwiched between non-woven fabric demonstrated adequate comfort and blocked penetration by bacteria and a 150-200 nm blood-borne virus, but allowed a 33 nm virus to pass. Improvements to prevent pinholes and other film defects are expected to lead to protective garments that meet OSHA standards for health care workers while providing adequate comfort.

Introduction

The 1992 OSHA standard mandates that protective clothing designed to protect against bloodborne pathogens must provide an efficient barrier to blood and body fluid penetration ("strike-through") of such viruses as HIV (~100 nm) and Hepatitis B (~50 nm) (USDL 1992). Unfortunately, thermal comfort must be sacrificed to prevent penetration by the smallest viruses (Vigo 1994; Schoenberger; White and Blood 1993). A polyvinylidene fluoride (PVDF)-based fabric coating can form a flexible, hydrophobic, microporous membrane (Kaminska et al., 200). We hypothesized that such a film could be applied to either *span the spaces between fibers* or be placed as a membrane between fabric layers, and that such a membrane (having a tortuous capillary bed porosity) would allow moisture vapor to pass while blocking passage of blood and other body fluids. The idea is to exclude bacteria & viruses while allowing air and water vapor to pass, thus keeping personnel comfortable but protected from "blood-borne" pathogens.

Materials and Methods

Independent Variables

Fabric construction: non-woven (PGI 94Q5: 55/45 cellulose/polyester, 3.7 oz/yd^2).
Fiber surface energy: hydrophilic *vs.* hydrophobic (use of Zony® fluoro-surfactants).
Formulation: PVDF copolymers, polymer blends, solvent (acetone & n-butyl acetate), concentration.
Coating technique: Cast directly on fabric *vs.* form film and apply as membrane sandwiched between fabric layers.

Dependent Variables

Water repellency (contact angle), comfort (drape, vapor transmission), low-pressure water penetration (dye "strike through"), and microorganism penetration — resistance to penetration by large and small viruses under high hydraulic pressure (ASTM F1670-95; 2psi, 60 min).

Results

Comfort

Conditions were found for which little or no reduction occurred for either drape/suppleness or moisture vapor transmission rate (MVTR) / breathability, for fabrics prepared by both direct and indirect coating techniques.

Biological Safety / Direct application

Conditions were found with adequate drape and MVTR, which passed the high-pressure strike through test and blocked transmission of *S. epidermidis* (~ 1 μm), but failed to block penetration of *Herpes Simplex* (100 nm) and polio (30 nm) viruses. Indirect application: Samples prepared with membranes cast from 15% polymer had adequate drape and MVTR, passed the high-pressure strike through test, blocked *Herpes Simplex*, but failed to stop penetration of the smaller poliovirus.

References

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Note

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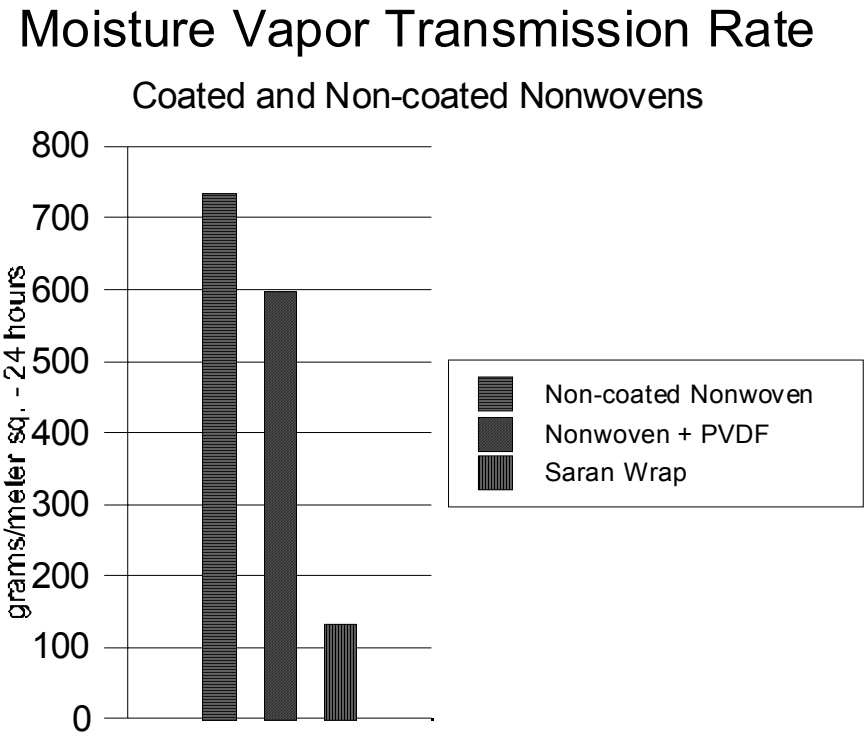
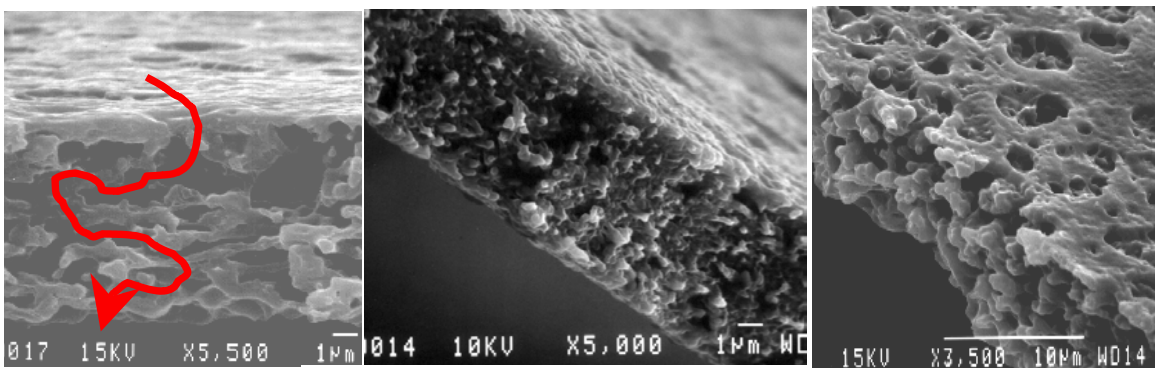


Figure 1. Moisture Vapor Transmission Rate.



Pores range up to approximately 1 µm.

Figure 2. Scanning Electron Micrograph of freeze-fractured PVDF-based coating.