Synthesis of a water-based TEOS–PDMS sol–gel coating for hydrophobic cotton and polyester fabrics

Nurul Hidayah Abu Bakar[a] *Wan Norfazilah Wan Ismail**[a] *Hartina Mohd Yusop*[a] *and Noreen Farzuhana Mohd Zulkifli*[b]

*Corresponding authors

[a]Faculty of Industrial Sciences and Technology, Universiti Malaysia Pahang Al-Sultan Abdullah, Lebuh Persiaran Tun Khalil Yaakob, Paya Besar, Kuantan, Pahang Darul Makmur, Malaysia

Email:

nurulhidayahabubakar95@gmail.com, tinaz4510@gmail.com, norfazilah@umpsa.edu.my

[b]Science & Technology Research Institute for Defence (STRIDE), STRIDE Main Complex, Taman Bukit Mewah Fasa 9, 43000 Kajang, Selangor Darul Ehsan, Malaysia

E-mail: noreen.zulkifli@stride.gov.my

ABSTRACT

Hydrophobic coatings inspired by the lotus effect have gained popularity for their ability to solve various problems. Achieving a hydrophobic surface requires nanoscale roughness and low surface energy materials. Traditional methods rely on harmful fluorinated chemicals, but the demand for water-based coatings has increased due to environmental concerns. To overcome challenges such as synthesizing stable low surface energy materials in water and finding suitable adhesives, the sol–gel process is explored. The sol–gel method, utilizing silica, alumina, and titania, is a versatile and commonly used approach. This study focuses on producing water-based hydrophobic coatings for cotton and polyester fabrics using a one-step sol–gel method. The coatings are evaluated for their hydrophobic properties, surface energy, morphology, elemental composition, strength, breathability, and durability. In this research study, a coating solution was synthesised by cross-linking tetraethyl orthosilicate (TEOS) and polydimethoxysilane (PDMS), then cotton and polyester fabrics were coated using a pad-dry-cure method. The coated fabrics exhibited improved hydrophobic properties, with water droplets remaining spherical and not penetrating the fabric surface. The highest water contact angle (WCA) was achieved at a TEOS to PDMS molar ratio of 1 : 0.25, indicating excellent hydrophobicity. FTIR analysis confirmed the formation of Si–O–Si bonds in the coating solution, while SEM-EDX analysis revealed successful adhesion of the coating to the fabric surfaces, particularly on cotton. The coated fabrics demonstrated altered surface morphologies and lower air permeability compared to uncoated fabrics. The air permeability of the cotton fabric was greatly reduced by 96.63%, while the reduction for coated polyester was only 55.43%. In tensile strength tests, both coated cotton and polyester fabric experience a reduction in breaking and load strength with cotton exhibiting less reduction in strength compared to polyester. The coated cotton and polyester fabrics maintain good hydrophobicity after exposure to prolonged moderate temperature. However, the hydrophobicity decreased with repeated washing cycles, indicating the need for improved stability and durability. On a positive note, the TEOS–PDMS coating demonstrated excellent resistance to abrasion, making it suitable for applications requiring durable and hydrophobic textile surfaces. These findings suggest that the TEOS–PDMS coating provides a promising approach for enhancing the hydrophobic and surface properties of cotton and polyester fabrics.