

A Review on super oleophobic surface on Textile material

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Abstract

The development of super oleophobic surfaces on textile materials has emerged as a breakthrough innovation with wide-ranging implications for various industries. Super oleophobic textiles repel oils and hydrophobic liquids, ensuring they roll off without leaving a trace. These surfaces are achieved through a combination of chemical treatments, physical methods, coatings, and nanomaterials, offering applications in fashion, healthcare, automotive, and environmental protection. Methods of creating super oleophobic surfaces involve chemical treatments using fluorinated compounds and silicones, nanostructures, plasma treatment, micro/nano structuring, coatings, self-assembling monolayers, nanoparticles, hydrophobic nanofibers, and topographical engineering. Evaluation methods include contact angle measurement, roll-off angle, oil repellency rating, oil absorption tests, durability testing, chemical resistance, water repellency, surface morphology analysis, wear testing, and real-world testing to assess the surface's performance. Applications of super oleophobic surfaces in textiles include stain-resistant clothing, medical and healthcare textiles, outdoor gear, industrial applications, automotive interiors, and filter media, offering benefits such as improved cleanliness, durability, and user experience.

Keywords: Coating, Oleophobic, Repellent, Surface roughness, Textile

Introduction

In recent years, the development of advanced materials and surface engineering techniques has given rise to remarkable innovations in various industries. Among these innovations, the emergence of super oleophobic surfaces on textile materials stands out as a breakthrough with far-reaching implications. Oleophobic surfaces, which repel oils and other hydrophobic substances, have gained significant attention due to their potential to enhance the durability, functionality, and performance of textiles in various applications. Super oleophobic surfaces on textiles exhibit an extraordinary ability to resist oil and other hydrophobic liquids, ensuring that they roll off the fabric without leaving a trace. This unique property is achieved through a combination of surface modifications and nanoscale engineering, resulting in textiles that are not only stain-resistant but also more comfortable and easier to maintain. These surfaces repel not only water but also oils and other liquids, making them highly desirable for self-cleaning, stain-resistant, and durable textiles. The development of such surfaces has opened new possibilities for textiles in fields such as fashion, healthcare, automotive, and environmental protection.

Researchers have explored various methods to create oleophobic surfaces on textiles, including chemical treatments, physical coating techniques, and the deposition of nanomaterials like nanoparticles or nanofibers. Many studies have used nanoparticles, such as silica, graphene, or metal oxides, to create super oleophobic surfaces. These nanoparticles are often applied to textiles through various coating techniques to enhance their repellency. Researchers have employed micro and nanostructuring techniques to alter the surface morphology of textile materials. This includes creating micro/nano-textures and patterns on the textile surface to reduce its contact area with liquids, thereby promoting oleophobicity.

The use of fluorinated compounds and chemicals like perfluorinated silanes has been explored to make textiles oleophobic. These compounds lower the surface energy of the textile, making it highly repellent to both water and oil. In response to environmental concerns, there is ongoing research into the development of super oleophobic surfaces on textiles using sustainable and biodegradable materials. These approaches aim to maintain repellency while minimizing the environmental impact. Super oleophobic textiles have applications in

a wide range of fields, including clothing and outdoor gear, medical textiles, and protective clothing in the industrial sector.

Methods of developing super oleophobic surface on textile materials

Creating a super oleophobic (oil-repelling) surface on textile materials involves modifying the fabric's surface to prevent oils and other hydrophobic substances from sticking to it. This can be achieved through various methods and materials.

Chemical Treatments:

Fluorinated Compounds: Fluorinated chemicals, such as perfluorinated silanes or fluoroalkyl chains, are commonly used to create super oleophobic surfaces on textiles. These compounds reduce surface energy, making it difficult for oils to wet and adhere to the fabric.

Silicones: Hydrophobic and oleophobic coatings, like silicone-based treatments, can be applied to textiles to make them oil-repellent. These coatings create a barrier that prevents oil from penetrating the fabric.

Nanostructures: Some chemical treatments involve creating nanostructures on the textile's surface. For example, nanoscale textures, such as nanopillars or nanowires, can be etched or deposited onto the fabric to reduce contact area with oils, making them roll off the surface.

Physical Methods:

Plasma Treatment: Plasma treatment can be used to modify the textile's surface by introducing functional groups or altering the surface energy, making it more oleophobic.

Micro/Nanostructuring: Textiles can be engineered with micro or nanostructures to reduce the surface area available for oil contact. This can be done through processes like laser ablation, anodization, or embossing.

Coatings and Sprays:

Applying superoleophobic coatings or sprays specifically designed for textiles is a practical and cost-effective approach. These coatings often contain a combination of hydrophobic and oleophobic agents that adhere to the fabric's fibers, preventing oil from sticking.

Self-Assembling Monolayers (SAMs):

SAMs can be used to modify textile surfaces with precise control over the chemical composition. By selecting appropriate molecules, you can create a super oleophobic surface.

Nanoparticles:

Incorporating nanoparticles like silica or titanium dioxide into textile coatings can enhance their oleophobic properties. These nanoparticles create a rough surface texture that minimizes oil adhesion.

Hydrophobic Nanofibers:

Electrospinning hydrophobic nanofibers onto textiles can create a rough, textured surface that repels oils. This method is often used for protective clothing.

Topographical Engineering:

Textile materials can be designed with specific surface geometries, such as microtextures or hierarchical structures, to minimize oil contact.

Evaluation Methods

Evaluating the performance of a developed super oleophobic surface on textile materials is crucial to ensuring its effectiveness in repelling oils and other hydrophobic substances. Here are some evaluation methods you can use:

Contact Angle Measurement:

Contact angle measurement is a common method to assess the oleophobicity of a surface. A high contact angle indicates a highly oleophobic surface. To measure the contact angle, place a droplet of the test oil (e.g., mineral oil) onto the textile material's surface and use a goniometer to measure the angle formed between the droplet and the surface. A larger contact angle indicates better oleophobic properties.

Roll-Off Angle:

This test evaluates how easily liquid droplets roll off the textile material. Tilt the textile sample and observe the angle at which a liquid droplet starts to roll off the surface. Lower roll-off angles indicate superior oleophobic behavior.

Oil Repellency Rating:

Use standardized oil repellency rating scales, such as the AATCC (American Association of Textile Chemists and Colorists) or ISO (International Organization for Standardization) standards. These standards provide a range of grades to classify a textile's resistance to different oil types.

Oil Absorption Test:

Measure the amount of oil absorbed by the textile material when exposed to a specific oil. Weigh the textile material before and after exposure to the oil to calculate the oil absorption percentage. A lower percentage indicates better oleophobic properties.

Durability Testing:

Assess the durability of the super oleophobic surface by subjecting it to abrasion, washing, or mechanical stress. This will help determine how well the oleophobic properties withstand wear and tear in real-world conditions.

Chemical Resistance:

Test the surface's resistance to various chemicals and oils it might encounter in its intended environment. Evaluate how the surface responds to different oils, solvents, and cleaning agents.

Water Repellency:

Super oleophobic surfaces should not compromise the fabric's hydrophobic properties. Evaluate the material's ability to repel water alongside oil repellency. Water contact angle measurements and water droplet roll-off angles can be useful for this assessment.

Surface Morphology Analysis:

Examine the microscopic surface structure of the textile material using techniques such as scanning electron microscopy (SEM) or atomic force microscopy (AFM). The surface should exhibit a rough and hierarchical structure that contributes to oleophobicity.

Wear Testing:

Subject the textile material to wear and friction conditions that mimic its intended use, such as rubbing, folding, or stretching. Evaluate the change in oleophobic properties after these mechanical stresses.

Real-World Testing:

Finally, conduct real-world tests by exposing the textile material to the actual working environment. Assess its performance in situations where oil and other hydrophobic substances are encountered regularly.

Application of super oleophobic structures

Super oleophobic surfaces are designed to repel oils and other hydrophobic substances, making them highly valuable in textile applications. Here are some key areas where this technology can be applied:

Stain-Resistant Clothing: The application of super oleophobic coatings on textiles can create stain-resistant clothing. This would be particularly beneficial in the fashion industry, as it would allow consumers to enjoy clothing that remains free from common stains such as oils, food, and beverages.

Medical and Healthcare Textiles: Super oleophobic coatings can be used on medical gowns, masks, and bed linens to enhance resistance to bodily fluids and other contaminants. This can improve infection control in healthcare settings.

Outdoor Gear: Textiles treated with super oleophobic coatings can be used for outdoor gear, such as tents, backpacks, and rainwear. These textiles would repel water, oils, and other outdoor elements, keeping users dry and comfortable.

Industrial Applications: In industrial settings, textiles are often exposed to oils and chemicals. Super oleophobic textiles can be used for protective clothing, aprons, and covers to prevent contamination and protect workers.

Automotive Interiors: Car seats, upholstery, and interiors can benefit from super oleophobic coatings, as they can repel oil-based stains, coffee spills, and other common mishaps, keeping the interior of vehicles cleaner and more durable.

Filter Media: Super oleophobic textiles can be used in air and liquid filtration systems, where they can resist the buildup of oil and other contaminants, leading to longer lasting and more efficient filters.

The advantages of super oleophobic surfaces on textiles are clear – they enhance the durability, cleanliness, and usability of textile products, while also improving user experiences. I am excited about the opportunity to explore potential collaborations with your organization to bring this technology to the textile industry.

Conclusion

The development of super oleophobic surfaces on textile materials represents a significant advancement with far-reaching implications across various industries. These surfaces, achieved through a combination of surface modifications and nanoscale engineering, have the remarkable ability to repel oils and other hydrophobic substances, making textiles stain-resistant, self-cleaning, and more durable. Researchers have explored diverse methods, from chemical treatments to physical coating techniques and the use of nanoparticles, to create these super oleophobic surfaces. Furthermore, there is a growing emphasis on developing sustainable and

biodegradable alternatives, addressing environmental concerns. The application of super oleophobic structures in diverse fields, including fashion, healthcare, automotive, and environmental protection, has the potential to revolutionize these industries.

Evaluation methods for super oleophobic surfaces are essential to ensure their effectiveness, including contact angle measurement, roll-off angle, oil repellency rating, and durability testing. Real-world testing is also crucial to assess performance in practical environments. The practical applications of super oleophobic textiles are numerous, ranging from stain-resistant clothing and medical textiles to outdoor gear, protective industrial clothing, and automotive interiors. These textiles provide enhanced durability, cleanliness, and usability, making them an attractive choice for various product categories.

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