Preparation of a superhydrophobic coating on a hydrophilic substrate for use as a liquid-absorbent material in medical applications

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Abstract

This study focuses on the development of superhydrophobic/superhydrophilic double-layer coatings on gauze for medical liquid absorption applications, particularly in wound dressings. Achieving superhydrophobicity on naturally hydrophilic gauze presents a significant challenge. Therefore, this research explores the use of silver nitrate-modified polydimethylsiloxane (PDMS). Silver nitrate (100 mM) was dissolved in deionized water, and the gauze was immersed in this solution for 15 minutes before being coated with PDMS at concentrations of 1%, 3%, and 5% using a spray technique. Scanning electron microscopy (SEM) was employed to analyze the surface morphology. The results demonstrated that increasing the PDMS concentration improved fiber thickness and water resistance but reduced surface roughness, which is crucial for achieving superhydrophobicity. The optimized conditions resulted in a water contact angle exceeding 150º. Additionally, the antibacterial properties of the samples were evaluated.

Introduction

Medical gauze is essential for wound care but is prone to bacterial contamination and excessive water absorption. To address these issues, a PDMS coating is applied to enhance hydrophobicity and serve as a barrier against microbial infiltration. This study develops PDMS-coated gauze to improve water resistance and antibacterial properties, thereby enhancing its effectiveness for medical applications in high-risk environments.

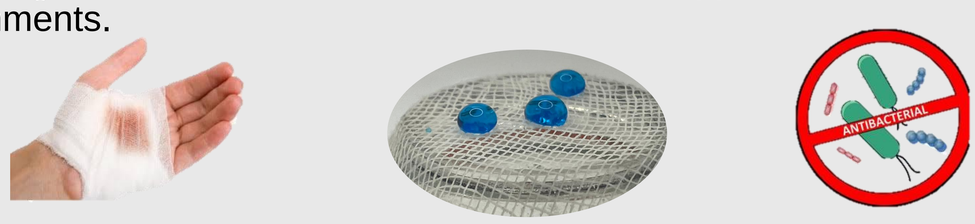


Fig.1 illustrates a gauze bandage, water droplets on the gauze, and an antibacterial agent.

Experiments

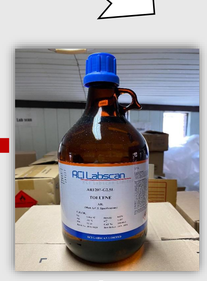

Gauze

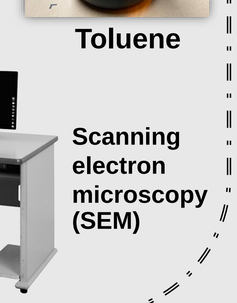
Immersed

Silver nitrate

DI water

ADDING


Toluene



Spray-coated

Characteristic


Water contract angle (WCA)


Optical microscope (OM)


Scanning electron microscopy (SEM)

Fig.2 shows the preparation steps and the tools used for sample analysis.

Discussion

SEM images show that uncoated gauze (Fig. 3(a)) has a rough surface, whereas PDMS coating smooths the surface. The surface becomes more uniform with increasing PDMS concentrations; however, excessive PDMS can accumulate and alter the gauze's structure. Water contact angle measurements reveal that gauze coated with 5% w/v PDMS (Fig. 5) exhibits a contact angle greater than 155.9°, indicating the highest hydrophobicity. Furthermore, gauze treated with 100 mM Silver Nitrate and then coated with PDMS (Fig. 7) demonstrates the best water-repellent properties. Gauze coated with higher PDMS concentrations becomes increasingly hydrophobic and displays a more uniform surface compared to uncoated gauze. However, excessive PDMS coating should be avoided, as the surface cannot retain large amounts of PDMS when applied in excess. In conclusion, PDMS coating enhances the hydrophobic properties of gauze and creates a smoother, more uniform surface.

Conclusion

Increasing the concentration of PDMS on gauze enhances hydrophobicity and surface uniformity; however, excessive coating may impair adhesion. Water contact angle measurements indicate that 5% w/v PDMS achieves a contact angle exceeding 155.94°, while uncoated gauze shows lower water resistance. Treatment with 100 mM silver nitrate further improves water resistance. Overall, PDMS coating significantly enhances the properties of gauze for medical applications requiring moisture resistance.

Results

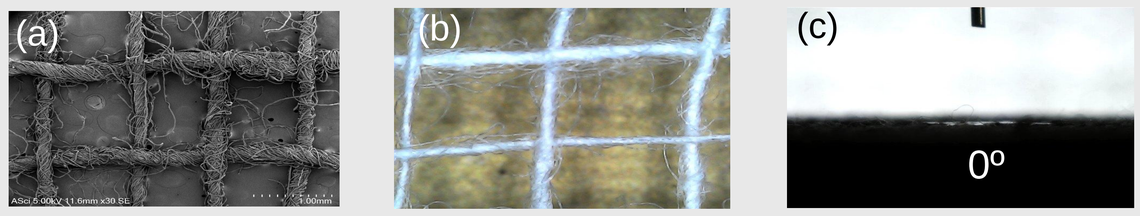


Fig.3 presents the analysis of the uncoated gauze using (a) SEM, (b) OM, and (c) WCA.

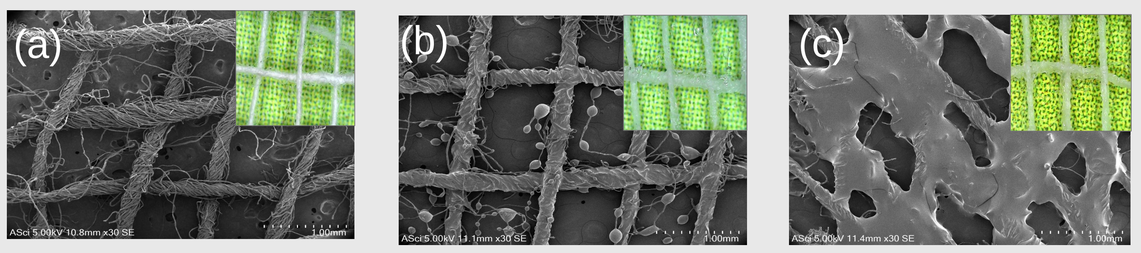


Fig.4 shows SEM images of gauze coated with PDMS concentrations: (a) 1% w/v, (b) 3% w/v, and (c) 5% w/v (inset showing the surface area).

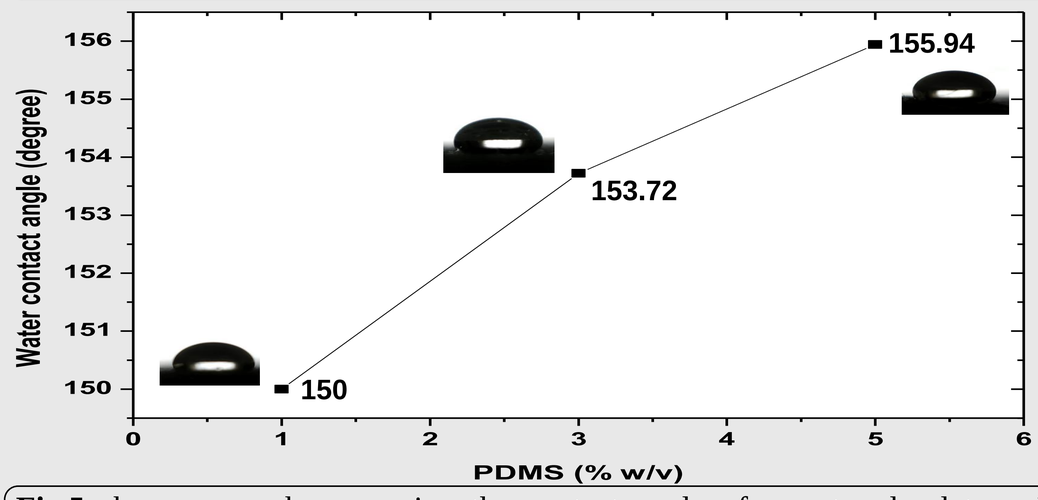


Fig.5 shows a graph comparing the contact angle of a water droplet on PDMS samples at different concentrations.

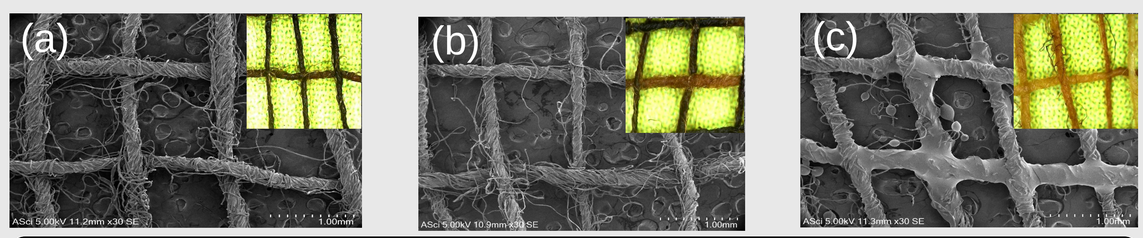


Fig.6 shows SEM images of gauze coated with $AgNO_3$ and PDMS concentrations: (a) 1% w/v, (b) 3% w/v, and (c) 5% w/v (inset showing the surface area).

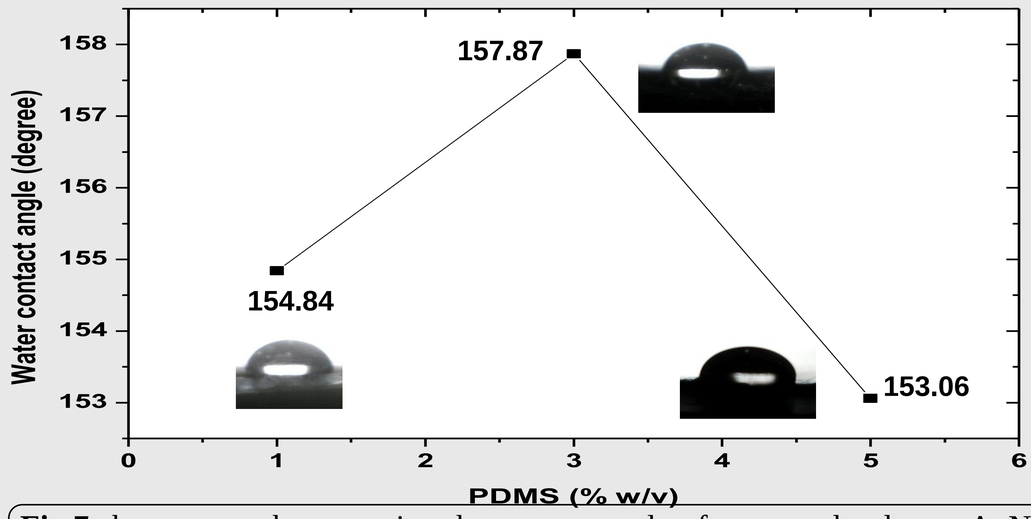


Fig.7 shows a graph comparing the contact angle of a water droplet on $AgNO_3$and PDMS samples at different concentrations.

Acknowledge

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Reference

Vipul Kumar Mishra1 , R Saini1 and N Kumar1 (2021) A review on superhydrophobic materials and coating techniques