Name(s)
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Project Number
38627

Project Title
Designing a Water Repellent and Breathable Material for Wound Dressings Using Nanotechnology

Abstract

Objectives/Goals
Surgical dressings today are suboptimal because they trap moisture and do not prevent penetration of water causing bacteria to grow, leading to infection. An ideal surgical dressing would be hydrophobic, which would prevent outside moisture from reaching the wound and stimulating bacteria growth. Bacteria does not adhere to hydrophobic surfaces because it is not energetically favorable. Also, the dressing would be breathable to allow the wound to release excess moisture that causes bacteria growth. Lastly, the material must be biocompatible.

Methods/Materials
Using a Sputter Coater, gold is deposited on pre-stressed polystyrene sheets (PS). The sample is heated and the PS sheets shrink. Because gold cannot shrink, it wrinkles to fit the size of a PS sheets. The wrinkles are transferred onto polydimethylsiloxane (PDMS) in a cast and mold method. This study analyzed the surface roughness and contact angle of 0 nm Au, 5 nm Au, 10 nm Au, 15 nm Au, and Tegaderm samples. The material was punctured 25 times. The Upright Cup method was used to find breathability of PDMS punctured, PDMS non-punctured, Open tube, and Tegaderm.

Results
As the Au thickness increases, the surface roughness also increases. The exponential nature of the relationship suggests an increase in Au thickness will minimally affect the surface roughness beyond a certain limit. Furthermore, as the Au thickness increases, the contact angle increases linearly suggesting an increase in hydrophobicity. Compared to Tegaderm, the contact angle of the 15 nm Au (135°) is 52° higher. Next, the Perforated PDMS sample in this study was found to be 230% more breathable than Tegaderm and 220% more breathable than Non Perforated PDMS. Furthermore, the sample was 180% more breathable than 26 WWB (waterproof, windproof, and breathable) fabrics on the market.

Conclusions/Discussion
In this experiment, nanotechnology was utilized to increase the the hydrophobicity of PDMS, making it a more suitable material for surgical dressing. The final contact angle is 135° (close to superhydrophobic). Hydrophobicity decreases the likelihood of infection from outside moisture and is antibacterial. The breathability was also improved by adding micro-perforations to the material. The breathability allows the wound to release excess moisture and prevent growth of bacteria that could lead to infection. Furthermore, PDMS is a biocompatible material.

Summary Statement
I created a material ideal for wound dressings because it is biocompatible, very hydrophobic, and 230% more breathable than the leading brand.

Help Received
I worked on my project at the research lab of Michelle Khine of Biomedical engineering at UCI. Graduate students Micheal Chu and Lancy Lin answered questions and taught me how to use the equipment. I designed, built, and performed the experiments myself.