The Effect of Increased Mucin Coating Thickness on Bacterial Cell Adhesion: Combined use of Spectroscopic Ellipsometry and Atomic Force Microscope

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Mucin is a naturally occurring polymer that belongs to the glycoprotein family (1). It is an amphiphilic molecule made of two main parts: a hydrophobic protein core and hydrophilic carbohydrate side chains (2). As a result of this structure, it can adsorb on hydrophobic surfaces and create a hydrophilic, lubricating surface. Mucin has been shown in recent studies (3) to have the potential to suppress the adhesion of microorganisms. The aim of this work is to develop a robust mucin coating that will serve as a bacterial suppressant coating. This has potential use in medical devices, such as catheters. In developing a coating technique, we created a multi-layer system consisting of a poly(acrylic acid) (PAA) copolymer as a base layer and a mucin layer on top, as this exploits the mucoadhesion interactions between PAA and mucin in bonding to the base. In an initial study we conducted, we showed the effectiveness of the presence of a thin mucin layer (5-8nm) on suppressing the adhesion of bacteria. The mucin coating reduced the numbers of two bacterial species (*Staphylococcus epidermidis* and *Escherichia coli*) by 70% in comparison to control copolymer surfaces without mucin. Our subsequent work drew upon recent research (2) that demonstrated the increased affinity of PAA to mucin at lower pH because of charge neutrality and increased hydrogen bonding (2). We have found that decreasing the pH of a mucin solution increases the absorbed mucin film thickness on poly(acrylic acid) copolymer, as determined with spectroscopic ellipsometry. The mucin thickness increased from *ca.*10 nm, when it was adsorbed from a mucin solution with a pH of 7, to *ca.* 20 nm when adsorbed from a solution of pH 3. Also AFM images revealed the presence of large voids between the adsorbed mucin clusters on the film adsorbed from ph7 solutions. This helped us create a better model for fitting the ellipsometry data taking these voids into consideration. From the bacterial cell counts on the surfaces we saw that the number of *Staphylococcus epidermidis* attached on a thicker mucin coating was 30% lower than on a thinner coating. On the other hand, the experiments on *E. Coli* adhesion showed that a thicker film performs no better than a thinner film. In conclusion, the use of PAA copolymer as a base of coating made us able to create a controlled mucin film thickness that has a better potential to suppress some potentially harmful bacterial species.

References

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