Reliable Bonding of Microfluidic Devices to Gold for Surface Plasmon Resonance Imaging of Bacteria

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Introduction:

Prior research has shown that the combination of surface plasmon resonance imaging (SPRi) and microfluidics allows for high-resolution imaging of bacterial biofilm growth.[1] However, designing such a system is a daunting task. When fabricating PDMS microfluidic devices, pieces are often permanently bonded to glass by treating the glass and PDMS surfaces with oxygen plasma.[2,3] When the glass is replaced with gold, as is necessary for SPRi, this method will no longer work and a new bonding method is required.

Prior research has shown that the use of (3-mercaptopropyl)trimethoxysilane (MPTMS) as an adhesion promotion layer creates a permanent bond between PDMS and Au.[4,5] The thiolated end of the MPTMS molecule favors interactions with the gold surface, while the silane is able to bond with the PDMS network, as shown in **Figure 1**. Various methods of monolayer deposition including liquid immersion, spin coating, and vapor depositon were assessed and it was determined that functionalization of gold surfaces using a solution of MPTMS in ethanol provided the most consistent bonding.[5] We propose the use of a MPTMS self-assembled monolayer to securely bond PDMS microfluidic devices to the gold surface of SPRi slides and prisms. This combination of microfluidics and SPRi will allow for real-time, label-free imaging of bacterial susceptibility to multiple antibiotic mixtures and concentrations.

Materials and Methods:

Microfluidic devices were fabricated by curing PDMS (Sylguard 184) on top of a silicon master mold (base : curing agent = 5:1). The device design consists of a main channel with submicron constrictions branching off it and connecting to seven food chambers. Preliminary experiments to observe interactions of *Staphylococcus aureus* with varying concentrations of penicillin streptomycin were conducted in PDMS devices bonded to glass and observed with an optical microscope.

Gold-coated SPRi slides (HORIBA) were modified in a 25mM MPTMS solution in absolute ethanol for 2 hours, rinsed with absolute ethanol, and dried with argon. PDMS devices were treated with oxygen plasma (Anatech SP-100) and placed on the modified gold surface. The food channels were filled with 1000X and 200X dilution of penicillin streptomycin and the main channel was filled with a bacterial solution of *S. aureus* in lysogeny broth growth media.

Results and Discussion:

Filling of devices bonded to MPTMS functionalized gold showed that the MPTMS adhesion layer provided a leak free seal for the microfluidic network. Growth of *S. aureus* in new devices showed the that the toxicity of MPTMS did not have any affect on the growth of the bacteria.

In preliminary experiments with the constructed system, the effect of the penicillin/streptomycin (pen/strep) cocktail concentration was observed, as the growth of *S. aureus* was inhibited in food chambers containing higher concentrations of pen/strep.

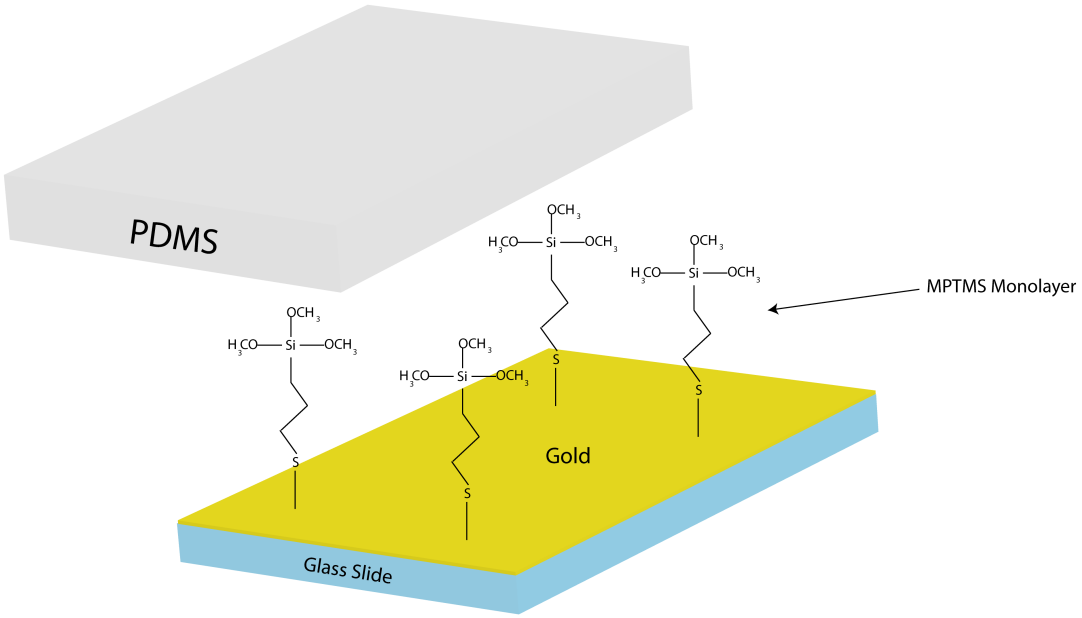


Figure 1: MPTMS Adhesion Layer on Gold

References

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