CASE STUDY

MasterSil 155: Used on Printed Circuit Board for the Portable Molecular Diagnostic System

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Overview of MasterSil 155

Master Bond's MasterSil 155 is a two-component silicone used for applications that has where electrically conductivity is needed. This graphite filled system bonds well to most substrates such as metals, plastics, and rubbers, and it also performs well when subjected to rigorous thermal cycling and shock.

Application

Portable molecular diagnostic systems can rapidly detect pathogens in the field, but pathogens are often present in amounts below the detection limit of these instruments. To address this, a researcher at the University of Hawai'i at Mānoa developed a portable point-of-care sample preparation system using electroflotation to concentrate pathogenic organisms. Water electrolysis was used to generate hydrogen and oxygen micro-bubbles that displaced suspended cells into a recovered concentrate, a process known as electroflotation. During this process, a surface coating was necessary to protect the underlying electrical traces from corrosion. MasterSil 155 was used as a corrosion-resistant coating for PCB electrode arrays for the electroflotation concentration of microorganisms for pathogen detection.

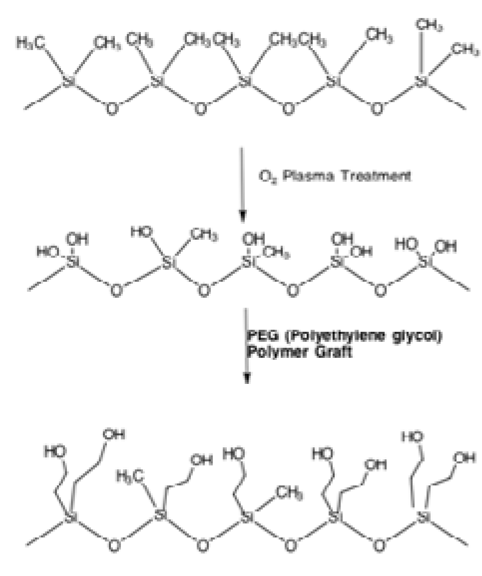

Figure 1. Reaction schematic used to modify the PDMS chains of MasterSil 155 to impart it with long-term hydrophilicity. MasterSil 155 was first subjected to O_2 plasma treatment, and then PEG was grafted onto it, thus functionalizing it with –OH groups.

Process Description

MasterSil 155 is based on polydimethylsiloxane (PDMS) chemistry and is graphite filled. I As shown in **Figure 1**, a two-step treatment was used wherein MasterSil 155 was applied to the electrode array surface of the PCB of the electroflotation setup and then cured in a box oven for 30 minutes at 225°C, followed by an oxygen plasma treatment to generate silanols. Because silanols are unstable, the surface undergoes hydrophobic restoration within hours. Therefore, the second step involved the grafting of polyethylene glycol (PEG) to introduce hydroxyl groups (–OH) onto the surface of MasterSil 155 by submerging the electrode array in a glass petri dish containing PEG for 5 min, followed by a thorough deionized water rinse.

Results

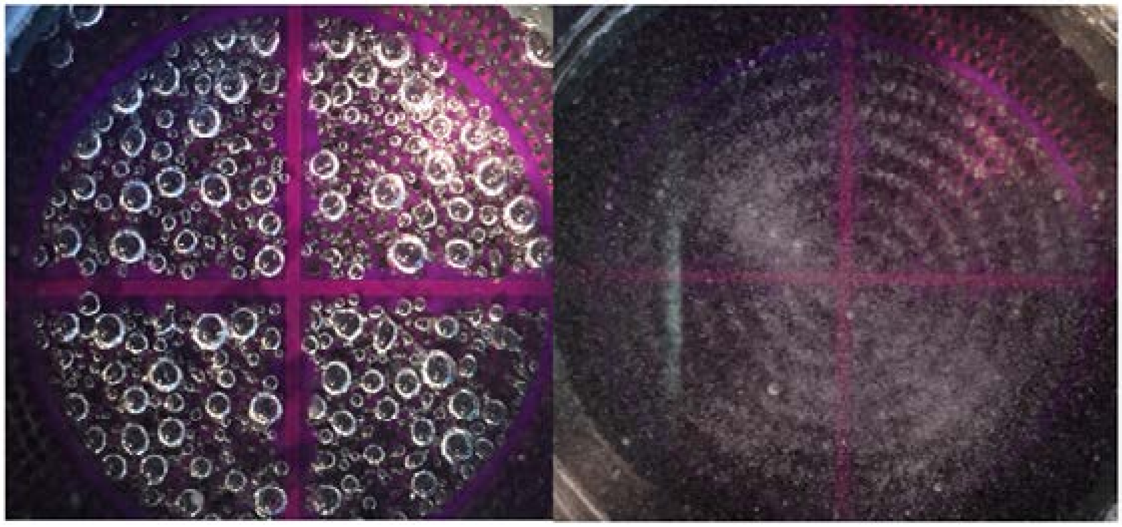

Figure 2. (left) Unmodified MasterSil 155 and (right) MasterSil 155 modified by O_2 plasma treatment and subsequent PEG grafting.

Electroflotation involves the electrolysis of water, which generates oxygen and hydrogen gas microbubbles, but this electrochemical reaction can be hindered by the electrical resistivity of the microbubbles if they are not released quickly enough. The hydrophobicity of the electrode surface affects how long a bubble resides on the electrode, and when a large bubble resides on the surface of the electrode, it increases the ohmic resistance to current across the electrode/electrolyte interface.

Figure 2 (left) shows that unmodified hydrophobic MasterSil 155 produced large air bubbles that lingered during electrolysis. However, after O_2 plasma modification and subsequent PEG grafting to introduce –OH groups, MasterSil 155 was rendered hydrophilic. This modification allowed the bubbles that formed during electrolysis to quickly coalesce and escape from the electrode (**Figure 2**, right), ensuring the current remained stable in the range of 325–350 mA at a voltage of 6 V.

References

Diaz, L. M. Point-of-care electroflotation of dispersed, low tolerance pathogens improves detection rates by loop mediated isothermal amplification. Masters Thesis. 2017. https://scholarspace.manoa.hawaii.edu/handle/10125/62559