Amphiphilic Silicones with Modern Utility for Marine and Medical Applications

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Silicones are extensively used in broad applications, particularly for non-toxic, foul-releasing marine coatings as well as for medical devices such as intraocular lenses (IOLs) and catheters. The utility of silicones stems from unique elastomeric mechanical properties, oxygen permeability, and resistance to degradation. However, the hydrophobicity of silicone surfaces limits their antifouling character. As a result, silicone marine coatings are prone to accumulate a variety marine organism, particularly under static conditions. Silicone IOLs do not inhibit ongrowth of lens epithelial cells (LECs) which leads subsequent posterior capsule opacification (PCO). Silicone catheters are prone to infection and to thrombosis due to the accumulation of bacteria, proteins, and platelets. Thus, we have developed amphiphilic surface modifying additives (SMAs) for facile modification of silicones, including dimethyl- and diphenyl-type silicones. These SMAs are comprised of a hydrophobic siloxane tether (of varying lengths) and a hydrophilic poly(ethylene oxide) (PEO) segment [HSi-ODMS$_m$-*block*-PEO$_8$-OCH$_3$]. SMA-modified silicones coatings exhibitred a dramatic increase in water-driven surface hydrophilicity, leading to a resistance to biofouling with as little as 1 weight % of SMA. Such coatings were able to dramatically decrease fouling by marine organisms in both lab assays and ocean tests. Resistance to LEC ongrowth was also observed with the incorporation of SMAs into a diphenyl silicone, and improved with longer tether lengths. SMA-modified silicones also showed resistance to bacterial adhesion and thrombus formation, including under flow conditions.

Biosketch

Melissa Grunlan is a Professor of Biomedical Engineering at Texas A&M University (TAMU) and Holder of the Charles H. and Bettye Barclay Professorship in Engineering. She is also a TAMU Chancellor EDGES Fellow and Presidential Impact Fellow. She holds courtesy appointments in the Department of Materials Science & Engineering and the Department of Chemistry. Prof. Grunlan obtained a B.S. in Chemistry and M.S. in Polymers in Coatings from North Dakota State University and a Ph.D. in Chemistry from the University of Southern California. Her work is focused on the development of synthetic polymeric biomaterials for implanted medical devices and for regenerative engineering. She is a Fellow of the American Institute for Medical and Biological Engineering (AIMBE), the American Chemical Society (ACS), the ACS PMSE Division, and the Biomedical Engineering Society (BMES). Prof. Grunlan is also a Senior Member of the National Academy of Inventors. To learn more visit grunlanresearchgroup.org (website) and @MGrunlanLab.