Rational design of surface topography to control bacterial biofilm formation

ABSTRACT

Bacterial biofilms are a major cause of chronic infections in humans and biofouling in industrial settings. However, controlling biofilm formation remains challenging due to the high-level tolerance of biofilm cells to antibiotics and disinfecting agents. To overcome such challenges, we investigated how surface topography affects bacterial adhesion using well-defined micron-scale pillars and line patterns. Based on the obtained results, we proposed a set of principles for rational design of antifouling surfaces and validated the design using protruding hexagonal patterns, which can reduce biofilm formation of *Escherichia coli* by around 90%. Based on these results, we further developed a new strategy to remove established biofilms using biocompatible shape memory polymers with defined surface topography. These surfaces can both prevent bacterial adhesion and remove established biofilms upon rapid shape change with moderate increase in temperature, thereby offering more prolonged antifouling properties. We demonstrate that this strategy can achieve a total reduction of *Pseudomonas aeruginosa* biofilms by 99.9% compared to the static flat control. It was also found effective against biofilms of *Staphylococcus aureus* and an uropathogenic strain of *Escherichia coli*. The detached cells were found to be more sensitive to antibiotics than the original biofilm cells.

Dacheng Ren, Professor

Department of Biochemical & Chemical Engineering, Syracuse University

Dr. Dacheng Ren received his Ph.D. in Chemical Engineering from University of Connecticut in 2003. After finishing postdoctoral training at Cornell University, he joined Syracuse University in 2006. Currently, he is Stevenson Endowed Professor in the Department of Bio-medical and Chemical Engineering and the Director of Chemical Engineering Graduate Program. He also serves as the interim director of Syracuse Biomaterials Institute.

Dr. Ren received an Early Career Translational Research Award in Biomedical Engineering from the Wallace H. Coulter Foundation in 2009 and a NSF CAREER award in 2011. He was named the College Technology Educator of the Year by the Technology Alliance of Central New York in 2010. Dr. Ren is also a recipient of the Faculty Excellence Award from the School of Engineering and Computer Science at Syracuse University. Dr. Ren currently has 55 journal publications with an h-index of 28, 10 issued/pending patents, and more than 30 invited talks. Dr. Ren has broad research interests in biotechnology and biofilm control. His research has been supported by NSF, NIH, EPA, Wallace H. Coulter Foundation, Alfred P. Sloan Foundation, and industrial sponsors.