Learning from Nature: Development of Antibacterial Surfaces

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Formation of biofilms by human pathogenic bacteria is the most common cause of medical implant failure. Surface structuring represents an attractive method for the prevention of bacterial attachment to surfaces. Cicada wings were reported as the first example of a novel class of antibacterial surfaces, which are selectively lethal to Gram-negative bacterial cells. The bactericidal effect was found to be a function of the wing surface physical nanoarchitecture. Surfaces such as these represent an exciting opportunity for the development of a wide range of antibacterial biomaterials for industrial and biomedical applications. The work was extended to include the assessment of the bactericidal potential of *Diplacodes bipunctata* dragonfly wings and black silicon (bSi); a structurally similar surface fabricated using a simple and fast reactive-ion etching technique.

It was conclusively demonstrated that both the dragonfly wings and the bSi surfaces are lethal for tested types of bacterial cells, despite their differences in surface chemistry and wettability. Insect wings and bSi surfaces were lethal to the Gram-negative *Pseudomonas aeruginosa,* Gram-positive *Staphylococcus aureus* and *Bacillus subtilis* bacterial cells. Both surfaces were also effective against *B. subtilis* spores, which are highly resistant to most forms of sterilisation. The bactericidal efficiencies of both the wing and bSi surfaces were very similar in most cases, with each square centimetre killing in excess of 100,000 cells per minute in the case of *S. aureus*, however the bSi was almost twice as effective as dragonfly wings at killing *Pseudomonas aeruginosa* cells; inactivating > 70,000 cells cm-2 min-1. The bSi surface was also found to be lethal to red blood cells. bSi substrates that were infected with the Gram-positive *Staphylococcus aureus* cells and incubated with mammalian cells simultaneously killed the pathogenic bacteria whilst allowing the mammalian cells to proliferate over the surface.