Bactericidal activity of three-dimensional fatty acid crystals

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Abstract

Mechanobiocidal surfaces are those that kill microorganisms due to their physical structure alone, with little or no influence from chemical composition. It therefore stands to reason that mechanobiocidal surfaces can be fabricated from innocuous materials, provided the structure can be controlled. Fatty acids are ubiquitous in nature, inherently non-toxic and are some of the major constituents of insect cuticles which are known to be superhydrophobic and mechanobiocidal[1,2]. In insects, the cuticle forms nanoscale structures which are lethal to bacterial cells. Here, two ubiquitous fatty acids, palmitic acid and stearic acid, were assembled on graphite substrata to form ordered three-dimensional crystals. Depending on the recrystallization temperature, two different crystal structures could be formed; a platelet type structure, and small irregular rodlets. Both types of crystal structures exhibited some bactericidal activity against *Staphylococcus aureus* and *Pseudomonas aeruginosa*, however the platelet type structure was more effective. Both crystal structures were highly hydrophobic, however neither reached the water contact angle threshold defining superhydrophobicity i.e. 150°. The Cassie-Baxter theory of wettability states that entrapment of air pockets by rough surfaces leads to increased water contact angles. The platelet-crystal surfaces were less hydrophobic than the rodlet structures, and given that both structures were composed of the same material this suggested that the platelets were less effective at trapping air pockets. This may explain their enhanced ability to kill bacterial cells; air-pockets trapped on the surface of the crystals limits the available area with which bacteria can interact, as the cells cannot cross the air-water interface.

[1]Nguyen, S. H., et al., Colloids Surf. B., 2013, 106, 126-134.
[2]Ivanova, E. P., et al., Nat. Commun., 2013, 4, 2838-2844.