Bacterial Retention on Superhydrophobic Titanium Surfaces

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In this study, two-tier nano- and microscale quasi-periodic self-organized structures, mimicking the surface of the lotus Nelumbo nucifera leaf, were fabricated on titanium surfaces using femtosecond laser ablation. The first tier structure consisted of large grain-like convex features, ranging between 10 and 20 µm in size. The second tier structure was present on the surfaces of these features, where irregular undulations up to 200 nm wide were present. The introduction of the biomimetic surface patterns onto the titanium surface significantly transformed the surface hydrophobicity of the surface. Whereas the original surface exhibited a water contact angle of $\theta_W = 73\pm3^\circ$, the laser-treated titanium surface became superhydrophobic, exhibiting a water contact angle of $\theta_W = 166\pm4^\circ$. Subsequent investigation of the propensity for S. aureus and P. aeruginosa bacteria to interact with these superhydrophobic surfaces at the surface-liquid interface revealed a highly selective retention pattern for the two pathogenic bacteria strains. Whilst the S. aureus cells were able to successfully colonize the superhydrophobic titanium surfaces, no P. aeruginosa cells were able to attach to the surface (i.e., any attached bacterial cells were below the estimated lower detection limit).

Figure 1. Images, demonstrating the similarity of surface topography and wettability of structured titanium to Nelumbo nucifera: Scanning electron micrograph of the adaxial leaf surface of rough, water-repellent surface of Nelumbo nucifera (A) and a water droplet on a Nelumbo nucifera leaf (B); Scanning electron micrograph of femtosecond laser structured titanium surface (C) and water droplet on this surface (D)