Measuring the bacterial adhesion of a single microorganism on plastic surface with a new tailor-made system

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Science sometimes can be so easy. Novel methods in the field of bioadhesion are crucial to determine the antimicrobial efficacy of antimicrobial and antiadhesive surfaces. Experiments include cultivations with Escherichia coli K12 JM109 to reach bacteria adhesion on differential test surfaces in order to enable adhesion force measurements between bacterium and surface with a new micromanipulation system installed in an environmental scanning electron microscope (ESEM). Measuring systems in publications are mostly very theoretical [1, 2] and others are not optimal simulating the real world because the systems are unique and therefore not comparable. Main issue is the direction of the force initiation to the microorganisms. Most systems work with orthogonal movement by pushing and pulling the organisms from the surface (e.g. the operation mode of the cantilever of an atomic force microscope [3]). Tangential movement to the surface - analogue to a cleaning process like flushing surfaces with water, or cleaning with a cloth - is the method of choice. The new method is based on two main parts. First, the micro manipulation system - arisen from the microchip research sector - with a phenomenal positioning accuracy up to 0.5 nm enabled by three axis [4]. Second, there are special spring tables with different spring constants [5]. A measuring cycle starts with selecting a single bacterium on the test surface. Then the glass tip of the micromanipulator is positioned directly in front of the bacterium. Now the micro manipulator moves the glass tip parallel to the surface against the microorganism but exactly tangential to the surface and orthogonal to the spring table. While pushing against the bacterium, the force against the bacterium rises linear until the bacterium separates from the surface. It flips away and the spring table returns to its starting position. The environmental scanning electron microscope records and plots the whole process from zero point with no force to maximum position where the organism separates from the surface. The calculation of the breakaway force is simple: Spring constant of the spring table and the elongation of recorded force-distance-measurement are known. Both values inserted in Hook's law reveal the adhesion force for each single microorganism. This easy method is absolutely close to a real cleaning process and additionally everybody can attend and observe the measurement. No more complex charts, just images and measuring results. Science sometimes can be so easy.

[1] Dexter et al.; Appl. Microb.(1975) 298; [2] R.E. Baier; Bull. N.Y. Acad. Med. (1972) 48, 257; [3] Bobe, Wildbrett; CIT (2006) 1615; [4] http://www.kleindiek.com/mm3a-em.html; [5] http://www.kleindiek.com/stfma.html