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# **Bacterial attachment to micro- and nano-structured surfaces**

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by

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## Abstract

The ongoing interest in bacterial interactions with various surfaces, followed by attachment and subsequent biofilm formation, has been driven by the importance of bacterial activities in number of medical, industrial and technological applications. However, bacterial adhesion to surfaces has not been completely understood due to the complexity of parameters involved.

The study presented herein investigates the attachment pattern of nine medically and environmentally significant bacteria belonging to different taxonomic lineages: *Firmicutes - Bacillus*, *Gammaproteobacteria*, *Alphaproteobacteria* and *Bacteroidetes*. Physicochemical assessment techniques such as contact angle and surface charge measurements, atomic force microscopy (AFM), scanning electron microscopy (SEM), confocal microscopy (CLSM), as well as X-ray photoelectron spectroscopy (XPS), X-ray fluorescence spectroscopy (XRF) and time-of-flight secondary ion mass spectroscopy (ToF-SIMS) analysis were all employed in order to attain better insight into the factors that influence bacterial interactions with surfaces. Bacterial surface characteristics such as surface wettability and charge in addition to substratum surface wettability, tension, charge and chemistry were also considered. However due to the recent interest in designing micro-textured surfaces with antibacterial and/or antifouling effects the prime was given to the influence of micro- and nano-meter scale surface textures on bacterial adhesion.

The interactions between selected bacteria and glass, polymer and optical fibre surfaces were studied. Carefully designed methods for surface modification allowed alteration of the topography of glass, polymer and optical fibre surfaces while maintaining other surface parameters near constant. This allowed isolated assessment of only the effects of surface roughness on bacterial adhesion.

Obtained results indicated consistent cellular inclination towards the smoother surfaces for all of the tested species. Enhanced bacterial presence on the smoother surfaces was also accompanied by changes in the bacterial metabolic activity as

indicated by the elevated levels of secreted extracellular polymeric materials (EPS) and modifications in the cells morphology. The results indicate that nano-scale surface roughness exert greater influence on bacterial adhesion than previously believed and should therefore be considered as a parameter of primary interest alongside other well-recognized factors that control initial bacterial attachment.

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I may not say it enough, but you know I mean it: “THANK YOU”

## **Declaration**

I Natasa Mitik-Dineva declare that this thesis is my original work and contains no material that has been accepted for the award of Doctor of Philosophy, or any other degree or diploma, except where due reference is made.

I declare that to the best of my knowledge this thesis contains no material previously published or written by other person except where due reference has been made. Wherever contributions of others were involved every effort has been made to acknowledge contribution of the respective workers or authors.

I also declare that this theses has been professionally edited, however the extend of the editing only affected the grammar and style of the thesis and not its substantive content.

Signature \_\_\_\_\_

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## List of publications

### Book chapters

**N Mitik-Dineva**, PR Stoddart, JR Crawford, EP Ivanova, *Bacterial cell interactions with optical fiber surfaces* In: "Fiber Lasers: Research, Technology and Applications" to be published by Nova Science Publishers, Inc. (in press)

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**N Mitik-Dineva**, PR Stoddart, *Applications of Atomic Force Microscopy in Topographic Imaging* In: "The surface structure and properties of microbial cells on a nanometer scale" published by Nova Science Publishers, Inc.2006

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**N Mitik-Dineva**, J Wang, RC Mocanasu, PR Stoddart, EP Ivanova, *Impact on nano-scale roughness on bacterial adhesion*, ASM Annual Meeting, Adelaide 2007

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