Title
Salt-induced self-assembly of bacteria on nanowire arrays

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Abstract: With the development of integrated systems which seek to combine micro- to nanoscale structures with biological materials, the study of the chemical and physical interaction of biotic and abiotic components has gained pertinence. While previous research has focused on engineering anti-microbial surfaces against harmful pathogenic bacteria, the next generation of nano-bio hybrid systems require tuneable interactions to study and harness the potentially useful properties of biological cells. The field of bioelectrochemistry has arisen in recognition of this potential, and seeks to combine the optoelectronic properties of inorganic electrode materials with the synthetic and catalytic power of whole cells, such as bacteria. The acetogenic bacteria, Sporomusa ovata, has emerged as a model organism of bioelectrochemical synthesis for its unique ability to accept electrons from a polarized electrode in order to drive the metabolic reduction of CO2 to acetate. Such a reaction is crucial to the development of systems for artificial photosynthesis, and for the renewable production of fuels and commodity chemicals from atmospheric CO2. Due to the volumetric diffusivity of whole cell catalysts, high surface area electrodes, such as nanowire arrays, are desired to boost the bacterial catalytic performance. In this work, the physical interaction of S. ovata cells and vertical silicon nanowire arrays was investigated. When grown under conditions of increased ionic strength, S. ovata cells were found to undergo tuneable self-assembled parallel alignment with the nanowires. A Derjaguin-Landau-Verwey-Overbeek based model describing the kinetic and thermodynamic driving forces of bacteria-nanowire attachment is proposed. This insight into the nature of bacteria-nanostructure interactions has the potential to create artificially structured biofilms with not only improved catalytic performance, but induce new ensemble properties based on unnatural cell-substrate and cell-cell interactions, paving the way towards the next generation of nano-bio hybrid systems.

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