Particles as probes for understanding bacterial adhesion to surfaces

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Impact

Understanding adhesion of bacteria to surfaces can provide the following advantages:

Preventing Infection transmission

- Prevention of bacterial adhesion to skin
- Removal of adhered bacteria from skin

Controlling Biofilm formation

- Bacterial attachment to surfaces – precursor for biofilm formation
- Biofilms undesired – Catheters, dental, pipelines etc..
- Desirable biofilms – Bio-leaching and bioremediation

Biosensors and drug delivery

- Efficient design of biosensors
- Design cells as drug delivery carriers

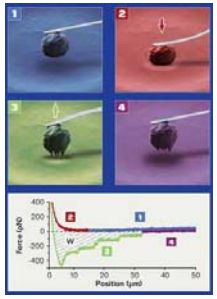
Figure: Bacterial adhesion to food contact surfaces plays a huge role in contamination

Common approaches to study bacterial adhesion

AFM with lateral force measurements

AFM based studies provide the following advantages:

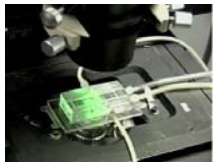
- Quantitative single particle – cell interaction forces
- Highly sensitive measurements which can often be regarded as noise in ensemble measurements



Flow cells with CLSM

Flow cells provide unique advantages over AFM based studies:

- Ensemble measurements with a choice to understand single particle interactions
- Understand the role and impact of hydrodynamics in the system



Particle – probes for investigating bacteria – substrate interactions

Forces of interaction to investigate (AB) : (columbic, hydrophobic, capillary forces etc…)

Forces of interaction under our control (BC) (columbic, hydrophobic, hydrogen bonding etc…)

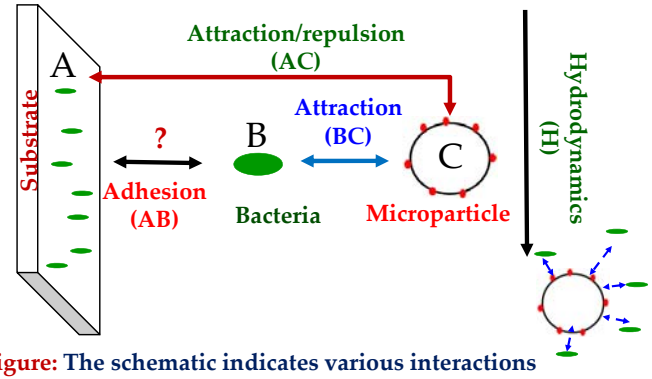
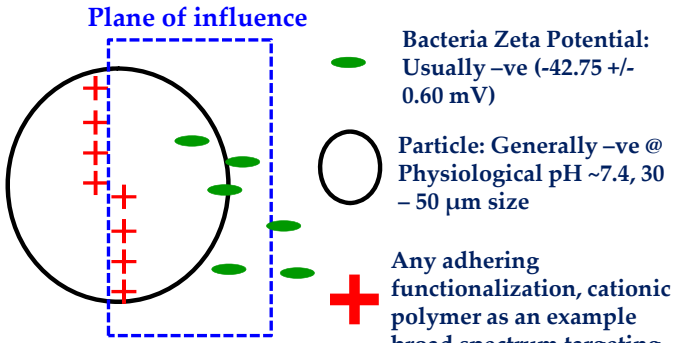


Figure: The schematic indicates various interactions between bacteria, substrate and particles that are relevant to understanding the problem of bacterial adhesion

Particle modifications



Results

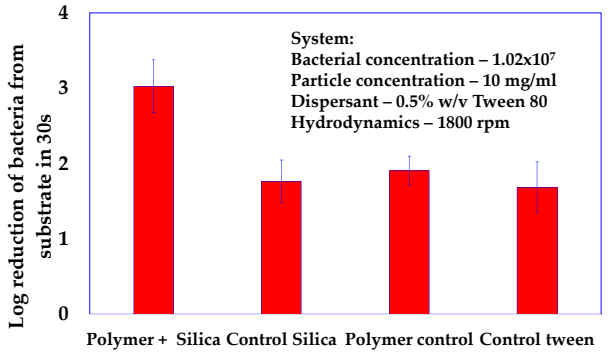


Figure: Particles modified to break bacteria – substrate interactions

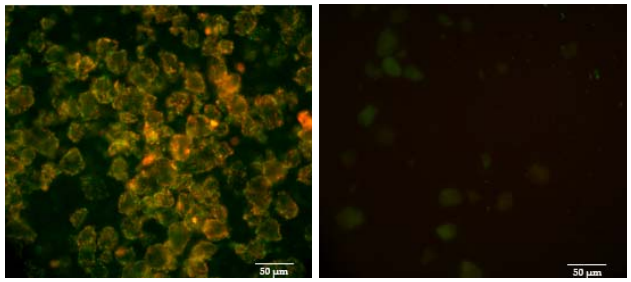


Figure: Modified particles with attached fluorescent bacteria (left) and unmodified particle with minimal bacteria attached on the right

Future experiments

- Quantify forces of interaction between bacteria, particle and substrate using AFM.
- Manipulate one or more interactions in the bacteria – particle - substrate system to strengthen or disrupt bacterial interactions with surfaces

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