Particles to enhance bacterial removal from skin during hand wash

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Particle design to enhance removal of bacteria from skin for hand wash applications

Bacteria – substrate interactions

- Van der Waal's attraction
- Coulombic repulsion
- Hydrogen bonding
- Capillary forces (upon drying)

Properties of bacteria, substrate and particle

- Bacteria: 65.1 mJ/m^2 (Zhang et al. *Environ. Sci. Technol.*, 2015, 49 (10), pp 6164–6171), - 30 mV (pH 7.4, 30mM KCl)
- Substrate: 29 mJ/m^2 (critical surface tension*)
- Particles: + 30 mV (pH 7.4, 30mM KCl)

Cationic particles

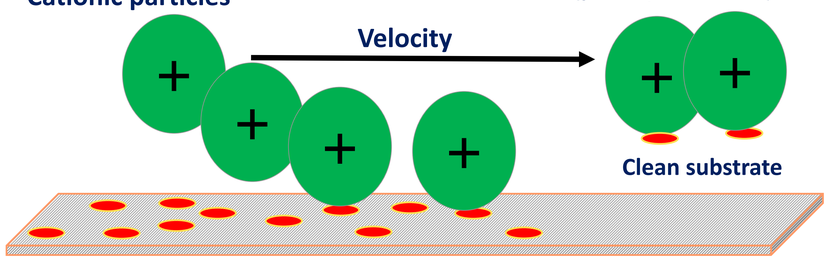
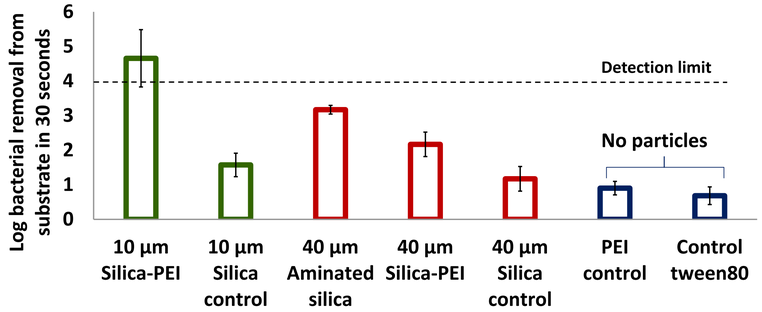


Figure: Schematic for removal of bacteria from artificial skin substrate using cationic particles

Factors affecting performance of particle enabled microbial removal

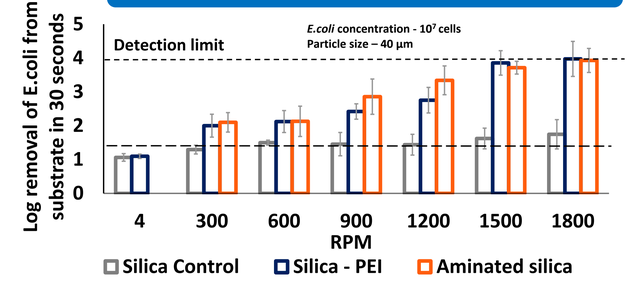
1. Force of interaction between bacteria and particle – Charge in this design
2. Contributions from Mass - Momentum of the particle (1)
3. Contributions from particle velocity -Momentum of the particle (2)

Disinfection potential of modified particles

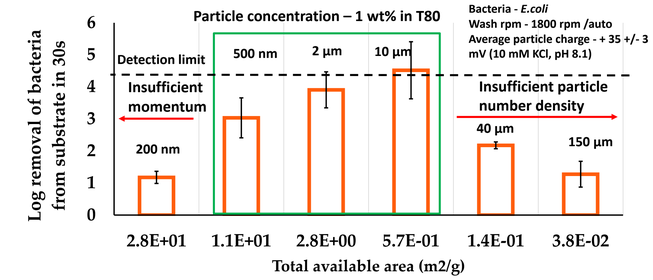


1. Modified silica particles perform significantly better with increasing velocity of particles
2. Control silica particles – Minimally affected by change in velocity/hydrodynamics

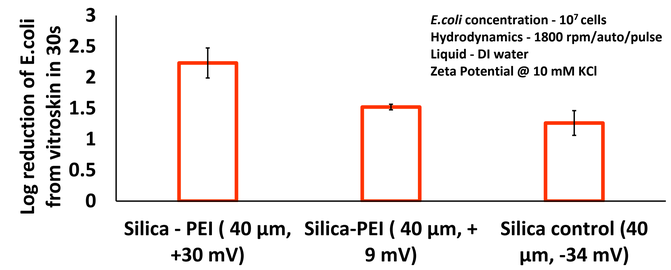
Results



Particle velocity affects efficacy of bacterial removal only for modified particles!



- Critical mass requirement for removal with modified particles
- Beyond critical mass, number density – critical parameter



Critical interaction force (charge) necessary for removal of bacteria with particles

Future experiments

- Quantify interaction forces –

1) Bacteria – substrate vs bacteria – critical adhesion forces required for removal.

2) Bacteria – particle – Contributions from particle shear, velocity and residence time for interactions

- Extend particles to other classes of microorganisms

Acknowledgement: This material is based upon work supported by Unilever, the National Science Foundation under Grant No. 1362060 and by CPaSS industry members

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Spring 2017 IAB Meeting – February 14 - 16, 2017