



A 2013 undercover study found only **5 percent** of people wash their hands correctly.

WOMEN wash their hands significantly more often, use soap more often and wash longer than men.

Sanitizers are less effective than soap and water because people may not use enough or may wipe it off before it has dried.

Soap and water are more effective than hand sanitizers at removing certain kinds of germs.

Researchers in London estimate that if everyone routinely washed their hands, **a million deaths** a year could be prevented.



Hand-washing reminder signs **increase** frequency and length of hand-washing.

Using soap and water to wash hands is more effective than water alone because the surfactants in soap lift soil and microbes from the skin.



7 percent of women and **15 percent** of men do not wash their hands at all after using the restroom.

Triclosan, an ingredient found in antibacterial soaps, is under review by the FDA due to potential health concerns and questionable benefits. A final decision is expected by September 2016.

According to the Centers for Disease Control and Prevention (CDC), failing to wash hands correctly contributes to nearly **50 percent** of all foodborne illness outbreaks.

Banned!

If soap and water are not available, an **alcohol-based** hand sanitizer containing at least 60 percent alcohol is the best alternative.

HAND-WASHING DOES NOT PROTECT people from diseases such as chicken pox, measles, influenza, tuberculosis and mumps, which are passed through the air or by sneezing, coughing or laughing.

Sources: Michigan State University Hand Washing Study, CDC

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 Properties of bacteria, substrate and particle

- Van der Waal's attraction
- Coulombic repulsion
- Hydrogen bonding
- Capillary forces (upon drying)
- Bacteria: 65.1 mJ/m² (Zhang et al. Environ. Sci. Technol., 2015, 49 (10), pp 6164–6171), - 30 mV (pH 7.4, 30mM KCl)
- Substrate: 29 mJ/m² (critical surface tension*)
- Particles: + 30 mV (pH 7.4, 30mM KCl)

Cationic particles

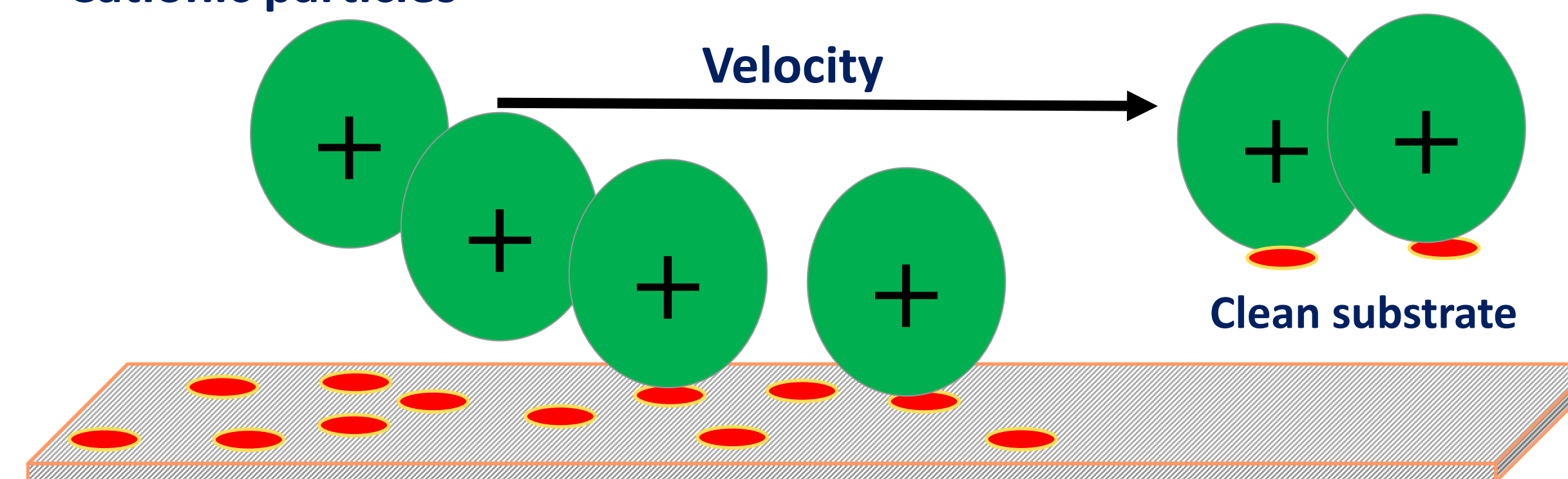
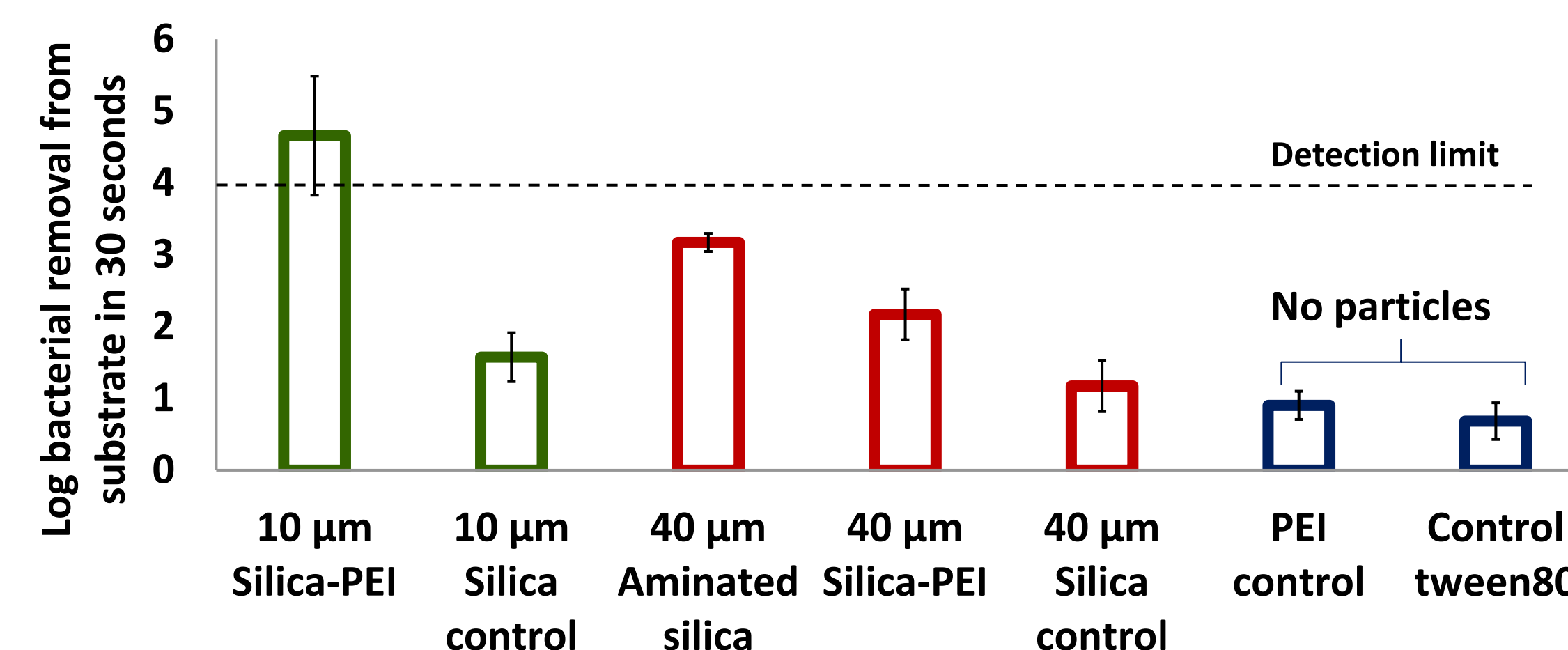


Figure: Schematic for removal of bacteria from artificial skin substrate using cationic particles

Factors affecting performance of particle enabled microbial removal

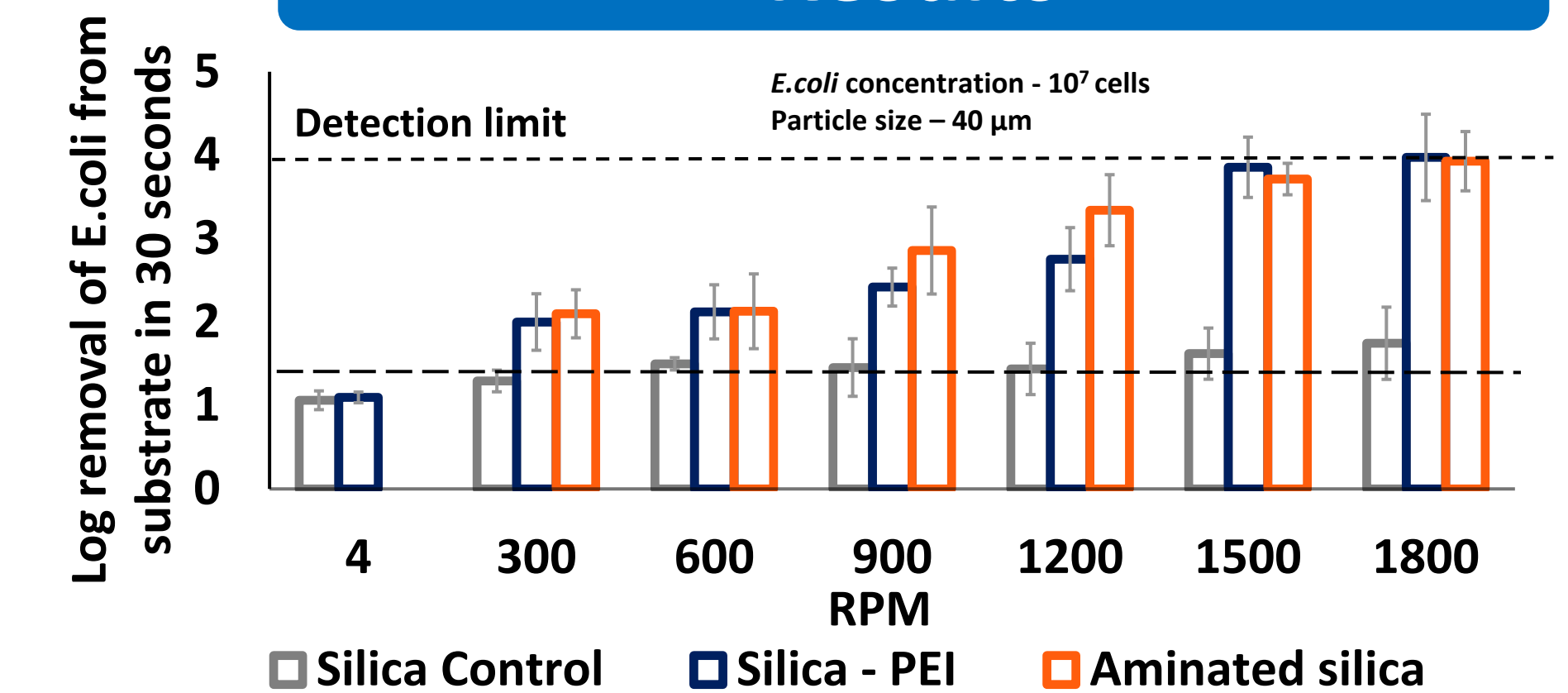
1. Force of interaction between bacteria and particle – Charge in this design
2. Contributions from Mass - Momentum of the particle (1)
3. Contributions from particle velocity -Momentum of the particle (2)

Disinfection potential of modified particles

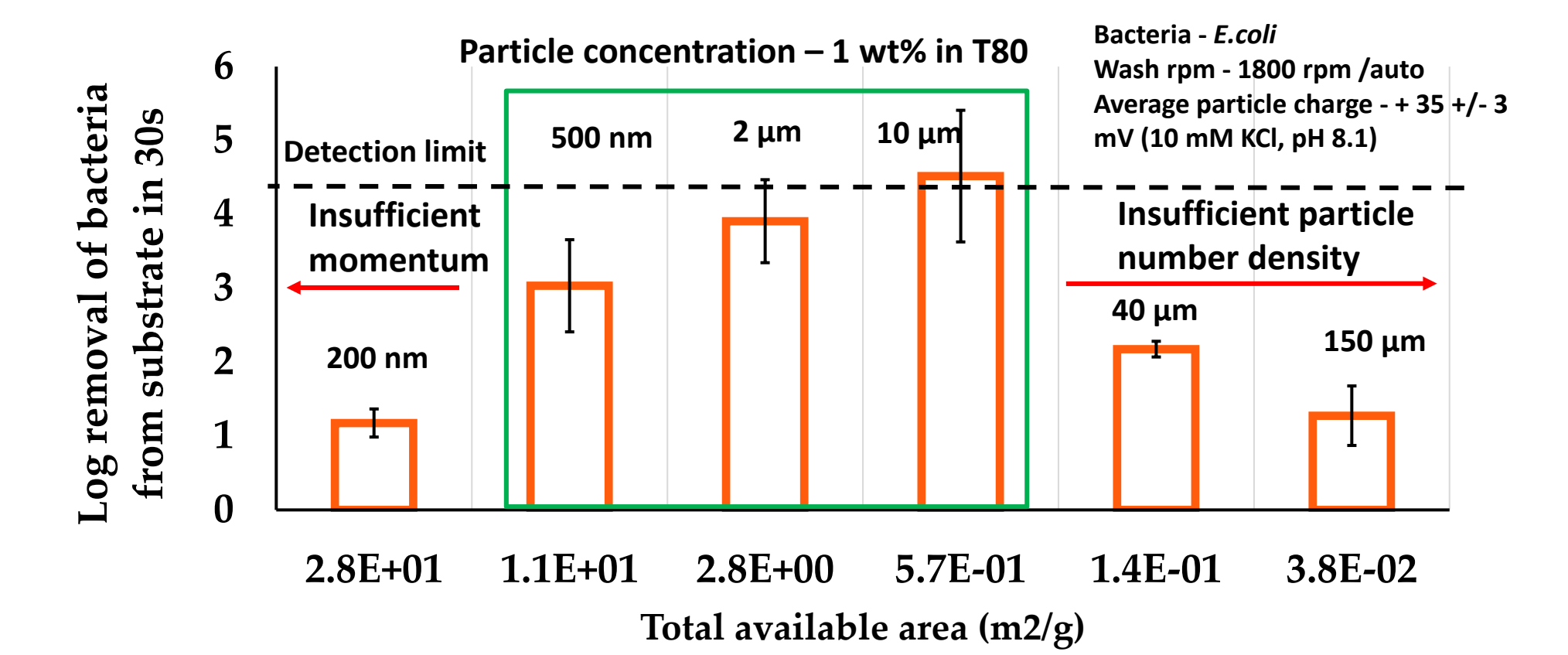


1. Modified silica particles perform significantly better with increasing velocity of particles
2. Control silica particles – Minimally affected by change in velocity/hydrodynamics

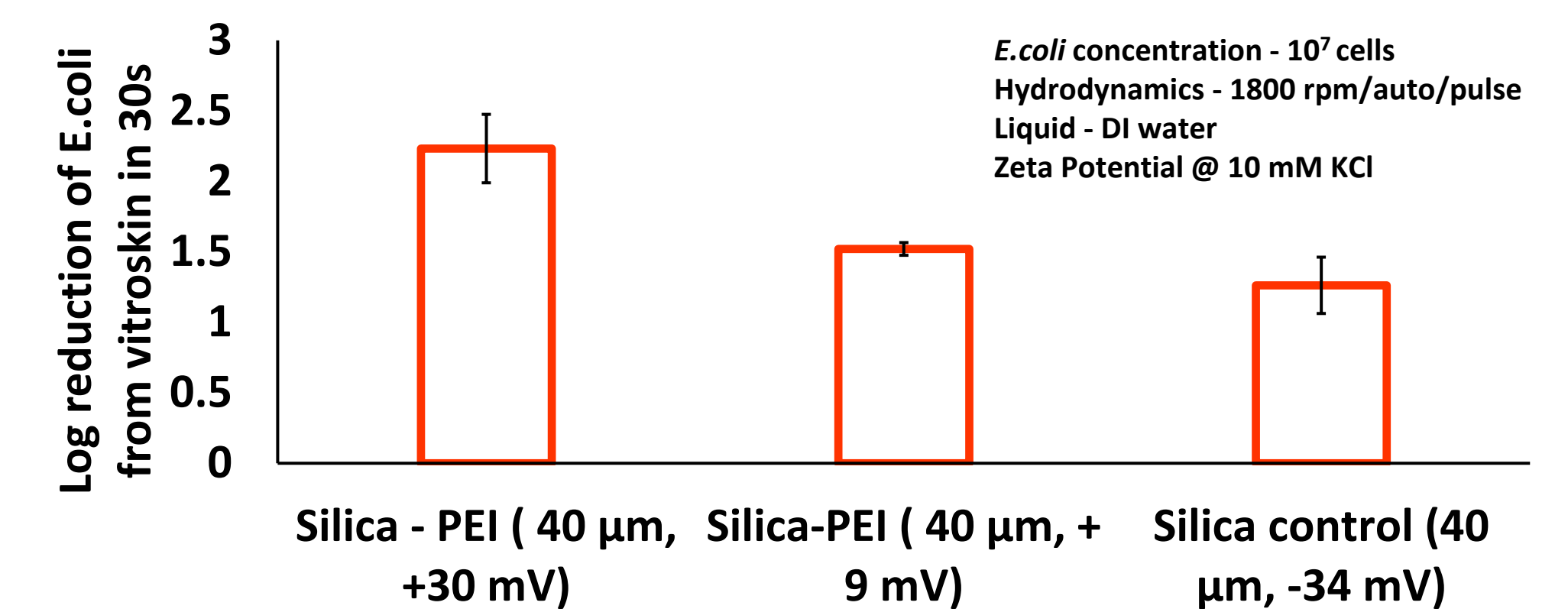
Results



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

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