

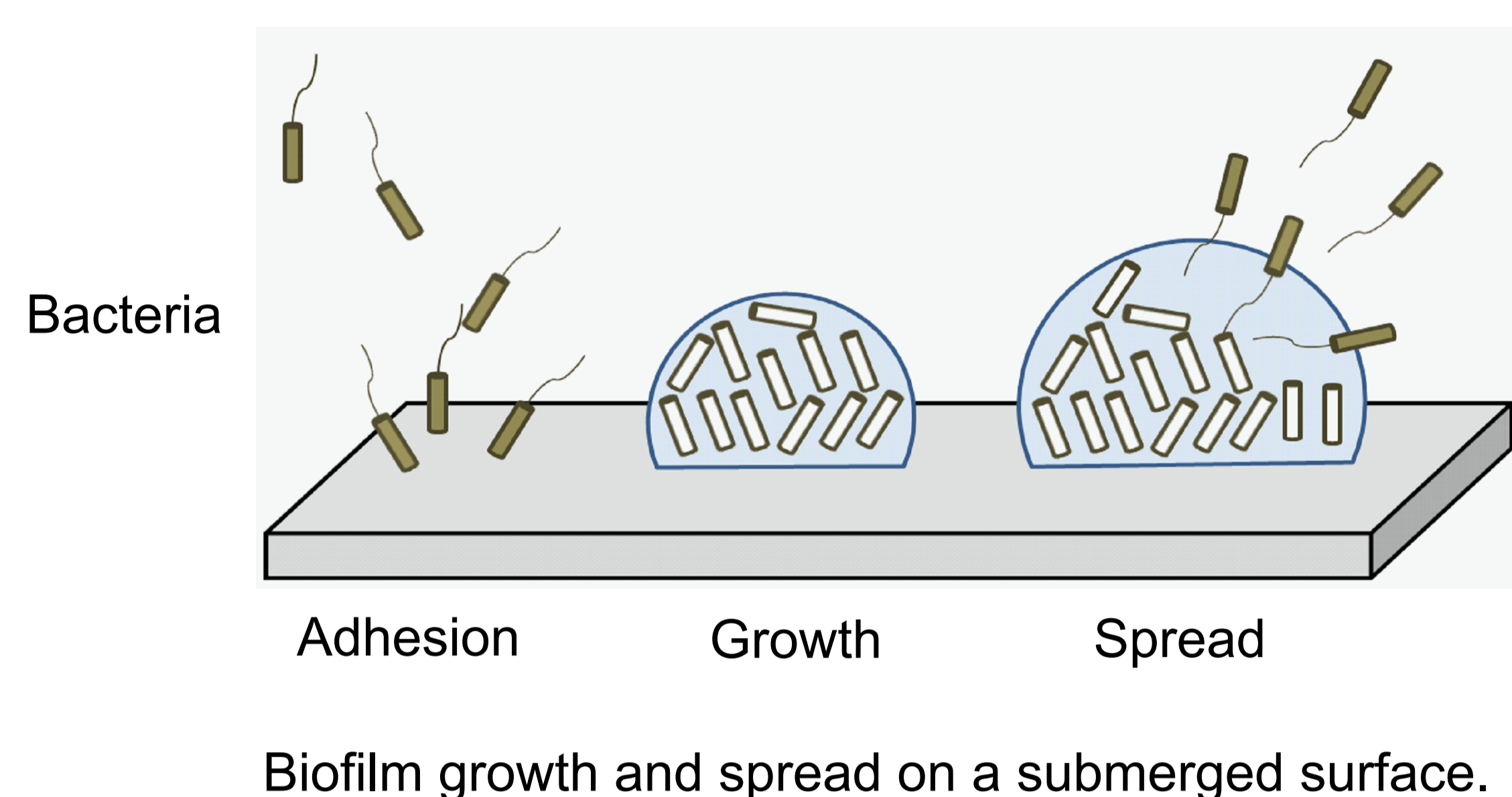


Anti-Microbial Polyethylene Surfaces

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Problem: biofilm formation



A cross-section through a water tube with biofilm.

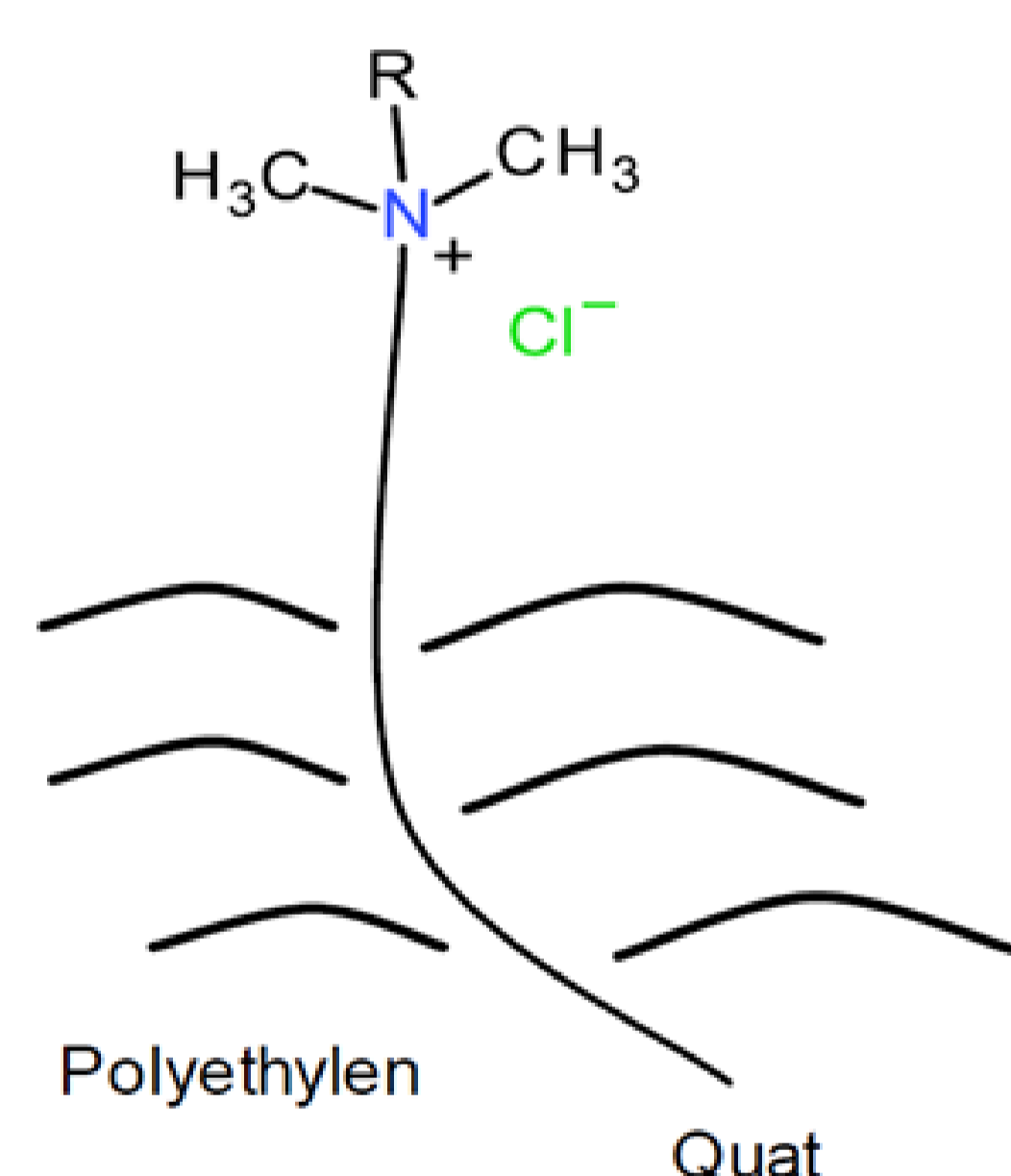
Research ideas

To kill germs as soon as they adhere; to produce biocidal surfaces

To prevent the adhesion of germs

- Quarternary ammonium compounds (quats) are biocidal.
- When mixed (compounded) with polyethylene, quats will segregate.
- Quats point the head group out of the polyethylene.
- Quats are anchored with a long hydrocarbon chain in the matrix.

→ Permanent biocidal polyethylene surfaces



Achievements (implementation)

- Four newly synthesized quats and five commercial quats were investigated.
- A test for the biocidal activity of the new surfaces was developed.
- It was shown that certain quats render polyethylene biocidal and were not washed out.
- The mechanical properties of the polyethylene do not deteriorate.
- The most promising quat was synthesized on a kilogram scale.

Surface properties

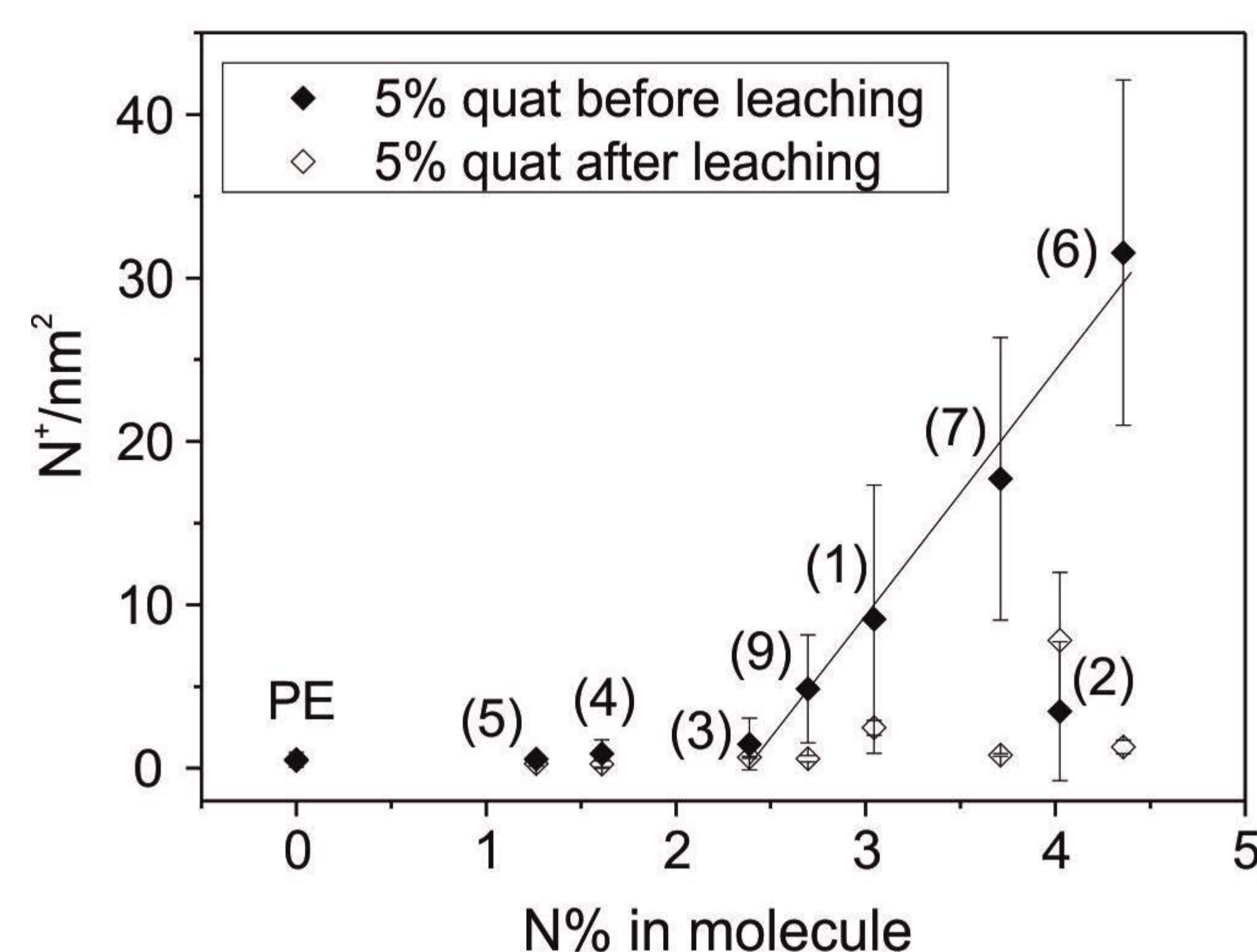


Fig. 1 Surface concentration of head-groups (N⁺) as a function of nitrogen in the molecule

- All surfaces with N⁺ larger than about 10 atoms/nm² are biocidal.
- If surface concentration is smaller than 10 atoms/nm², then the surface *can* also be biocidal.
- After leaching biocidal activity is retained.

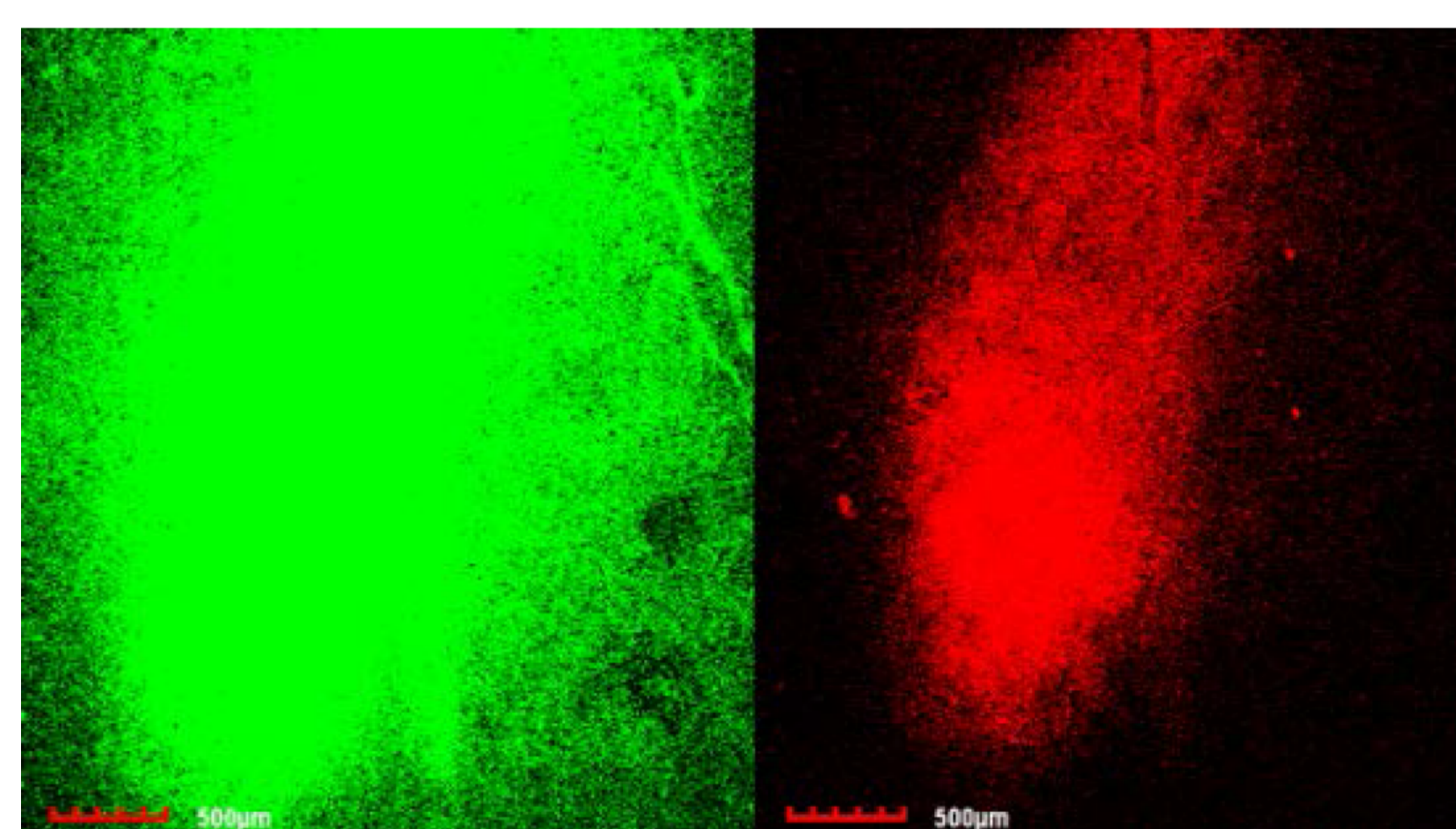


Fig. 2 Dead (green) and living (red) bacteria on treated (left) and untreated (right) PE

- Dead/life staining with fluorescent dye is performed.
- Biocidal activity of polyethylene with quat is demonstrated.

Next steps

- Are biocidal surfaces also biophobic, i.e., prevent the formation of biofilm?

References

Winkler, M; Siegmann, K; Plastic Having a Biocidal Surface and Method for Producing Said Plastic. WO 2014/174434 A1

Rossetti, F F; Siegmann, K; Köser, J; Winkler, M; Antimicrobial Polyethylene through Melt Compounding with Quaternary Ammonium Salts. *J. Appl. Pol. Sci.* in preparation.