

Antibacterial Polymer Coatings



Sandia National Laboratories

Michael Hibbs (PI), Mark Tucker, Gary Brown, Mollye Wilson, J. Bruce Kelley (PM)

Problem

Develop a Self-Decontaminating Coating that Kills Microorganisms, on Contact, in the Event of a Biological Attack

Technical Challenges:

- 1) Coating should be easy to apply (spray-on).
- 2) Coating should be durable.
- 3) Coating should kill a wide variety of microorganisms.



viruses (smallpox)¹ vegetative bacteria (plague)² spores (anthrax)³

¹ CDC/ Dr. Fred Murphy, Sylvia Whitfield

² Dennis Kunkel Microscopy, Inc.

³ www.srs.dl.ac.uk/Annual_Reports/AnRep01_02/anthrax.htm

Quaternary Ammonium Compounds (QACs) as Antibacterial Agents

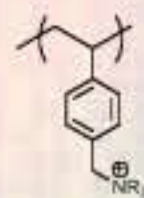


1) Positive charge promotes electrostatic interaction with negatively charged cell surface

2) Lipophilic chain promotes diffusion into and/or through the cell wall

Previous Work with QACs on polymers:

- Polymers exhibited higher antimicrobial activities than corresponding low molecular weight model compounds.¹
- QACs acting in concert are more effective than individual molecules.
- These polymers were all water soluble.

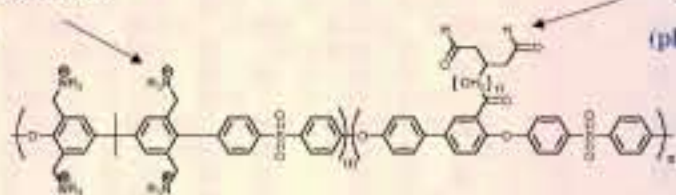


¹ Ikeda, I., Tazaki, S., Suzuki, Y. *Makromol. Chem.* 1984, 185, 999

Approach

Polymer has quaternary ammonium groups to kill bacteria...

(phase 1)



...and pendant aldehydes to kill spores

(phase 2)



Polymers can be dissolved in mixtures of water and alcohol,

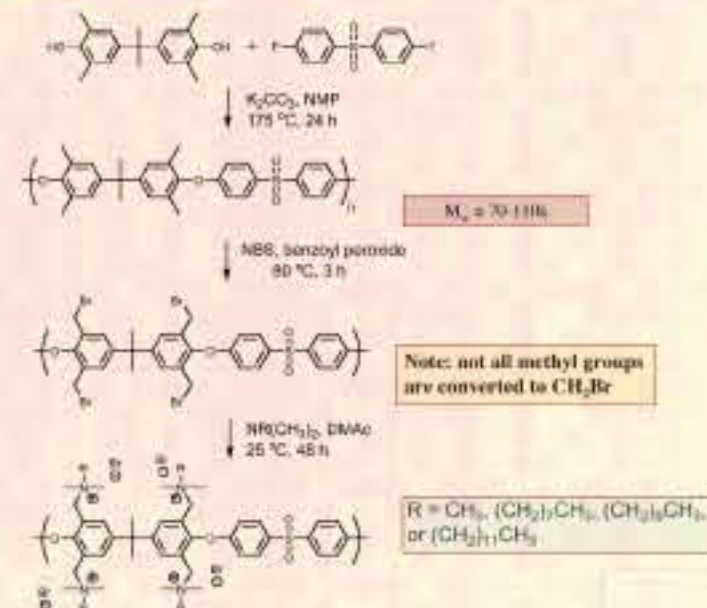


sprayed onto various surfaces,



and tested for biocidal activity

Synthesis of Sandia QA Polymer



Spraying and Testing



Spraying on coating

Dense polymer coating, 5-10 microns thick

Porous substrate



SEM of cross-section

Biological Testing:



Testing set-up



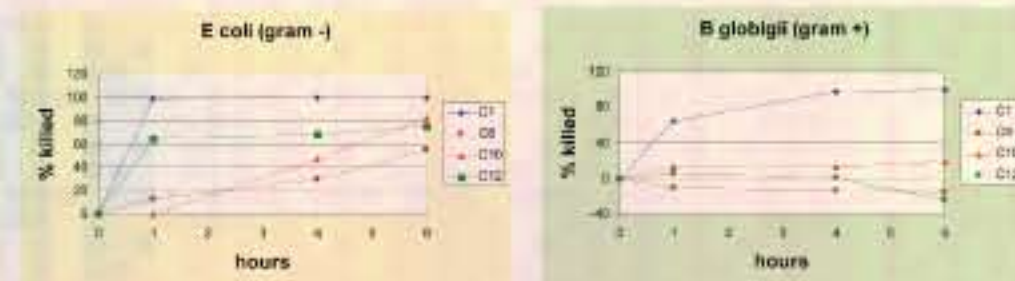
CARC-coated coupons



Sample plating

Results

% of organisms killed on coated surface vs. control surface



- The coating with the one-carbon alkyl chain is the most effective against both organisms.
- The gram negative bacterium is easier to kill than the gram positive one.
- To do:
 - test coating durability
 - test various coating thicknesses
 - prepare phase-2 coating

Potential Benefits

- Development of a passive first line of defense against biological attacks (directly tied to DHS mission*)
- Dual use - Antimicrobial coatings are of great interest in the medical and public health industries.
- Potential interest in expansion and scale-up from DHS, DTRA, DoD...
- Development of collaborations between 6338 and 6327

***From the Department of Homeland Security strategic goals:**
Protection — Safeguard our people and their freedoms, critical infrastructure, property and the economy of our Nation from acts of terrorism, natural disasters, or other emergencies.