We have recently shown that certain cationic conjugated polyelectrolytes (CPE) exhibit strong light-activated biocidal effects against potential pathogenic bacteria both in solution and for polymer anchored on a support as a physisorbed coating or brush covalently attached to a surface. More recently, we have found that hollow capsules formed by sequential layer-by-layer deposition of anionic CPEs and cationic polyelectrolytes on a sacrificial template show even more powerful ability to entrap bacteria on their surface and within the capsule cavities. These “micro roach motels” also exhibit efficient light-activated biocidal activity. The presentation will discuss the origin of the three effects that constitute the overall process: bacterial capture (a dark process), dark killing of bacteria and light-activated biocidal activity. The presentation will also introduce oligomeric cationic conjugated polyelectrolytes (OPE) that have been synthesized as molecules with definite structure and studied in the same context.

The results that will be discussed in detail include the following: the light-activated antimicrobial process requires oxygen and likely involves initial interfacial generation of singlet oxygen, possibly followed by generation of more corrosive ROI. Capture of bacteria by surfaces of CPE occurs as a dark process and likely involves association of cationic groups of the CPE with the phospholipid membrane; this may be subsequently followed by dark biocidal activity. The OPEs of definite size and structure exhibit similar biocidal activity in solution and when attached to surfaces. Advanced formulations with mixtures of anionic and cationic CPEs as hollow microcapsules show enhanced activity in both capture and light-activated killing of bacteria. The OPEs are being investigated for both biocidal activity and sensing applications.