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Fast-acting, Broad-spectrum antimicrobial polymers to combat a growing global health concern

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Abstract

Adherence of pathogens such as bacteria and viruses on various surfaces routinely leads to subsequent transmission to new hosts, significantly promoting the proliferation of potentially harmful organisms. This sequence is particularly worrisome in the case of antibiotic-resistant pathogens, which are becoming a global threat to human health. According to the U.S. Centers for Disease Control and Prevention, 1 out of every 20 hospital patients is affected by nosocomial infections, subsequently resulting in 100,000 deaths annually in the United States alone. Out of these, about 23,000 deaths are attributed to drug-resistant pathogens such as methicillin-resistant Staphylococcus aureus (MRSA). Strains often referred to as "nightmare superbugs" with highly elevated resistance to last-resort antibiotics have been reported all around the world in 2017. While metals (oxides) have been used as surfaces or introduced as nanoparticles into a broad range of substrates to serve as antimicrobial agents and eradicate a wide range of pathogens, they all suffer from eventual reservoir depletion or microbial resistance, and they tend to be pathogen- or condition-specific. Moreover, if not covalently bound or tightly embedded, these nanoparticles can leach into the environment and introduce additional health concerns. In this study, we first discuss a photodynamic polymer composed of an olefinic thermoplastic elastomer modified with zinc tetra(4-N-methylpyridyl) porphine (ZnTMPyP4+), a photoactive antimicrobial, and show that this combination is effective at inactivating 5 bacterial strains including MRSA, 3 different viruses, and a fungus upon exposure to noncoherent light. By achieving antibacterial and antiviral efficacies of at least 99.89%, this methodology, which relies on the formation of singlet oxygen, constitutes a non-specific and highly successful route by which to eliminate harmful pathogens upon simple exposure to visible light and oxygen. Another effective strategy employs only water and a pH jump to kill 99.9999% of antibiotic-susceptible/resistant bacteria and several viruses in just 5 min.

Biography

Richard J Spontak is a Distinguished Professor at North Carolina State University. He received his B.S. and Ph.D. degrees in Chemical Engineering from Penn State University and UC Berkeley, respectively. He then pursued post-doctoral research at Cambridge University before joining P&G. He has published over 290 peer-reviewed journal papers, and his work has been featured on 29 journal covers and cited over 12,000 times (Google Scholar). He is the recipient of numerous honors and awards such as the Co-operative Research Award in Polymer Science & Engineering (American Chemical Society), the Ernst Ruska Prize (German Society for Electron Microscopy), the Chemistry of Thermoplastic Elastomers Award (American Chemical Society), the Colwyn Medal (Institute of Materials, Minerals and Mining), and the International Award (Society of Plastics Engineers). An elected fellow of the American Physical Society and the Royal Society of Chemistry, he is a member of the Norwegian Academy of Technological Sciences.

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