

Siemens Competition

Math : Science : Technology

Regional Finalist

Names: Devorah Saffern and Julie Vaughn

High School: Ma'ayanot Yeshiva High School and Canyon Crest Academy

Mentor: Dr. John Jerome, Dr. Miriam Rafailovich

Project Title: *Investigating the Physical Antibacterial Properties of Graphene, Graphene Composites, and Phase-Separated Polymer Blends*
(Materials Science/Nanoscience; Microbiology)

Bacterial infection is a large source of worldwide disease, and bacterial biofilms can have corrosive effects on the environment and civil infrastructure. Usage of chemical antibiotics can lead to antibiotic-resistant bacteria, and utilizing these methods to kill bacteria could potentially harm other organisms. There are, however, examples in nature of surfaces that physically kill bacteria, such as cicada wings. The goal of this study was to synthesize and characterize a number of surfaces that are mechanically bactericidal. The antibacterial properties of a pure graphene coating were examined first, and demonstrated significant selective antibacterial properties. Polymer phase-separated blends were investigated next, as microstructure formation was induced in an attempt to form biomimetic structures similar to those of cicada wings. Analysis of microstructure formation using atomic force microscopy revealed that the microstructures formed were often not tall enough to be comparable, but certain blends showed promise. Lastly, novel alternative polymer blends involving the direct incorporation of graphene into the polymers were tested. One such surface destroyed a large percentage of bacteria. The results demonstrate that graphene and polymer-based surfaces have enormous potential to save lives by physically eliminating bacteria that could otherwise cause biofilm development and disease.