

Siemens Competition

Math : Science : Technology

Regional Finalist

Names: Kwangmyung Choi, Arun Soni, and Russell Charnoff

High School: Canyon Crest Academy, San Diego CA, Staples High School, and Hebrew Academy of the Five Towns and Rockaway

Mentor: Professor Miriam Rafailovich

Project Title: *Synthesis and Characterization of Graphene Nanoparticle Infused Polyethylene Nanocomposite Material for Enhanced Mechanical and Thermal Properties (Materials Science/Nanoscience)*

Current conventional metal-alloy heat exchangers are costly, difficult to work with, and corrosive. A polymer-based heat exchanger system could open new doors to inexpensive, lightweight, and long-lasting heating and ventilation systems. Nanocomposite technology, in which nanoparticles are incorporated into a polymer's matrix, could create more thermally conductive polymer composites. In this study, graphene nanoplatelets were infused with low-density polyethylene at varying concentrations through the melt-blending method, and characterized with various mechanical and thermal tests. Contrary to previous literature, which shows decreasing mechanical strength with the introduction of nanofillers, the nanocomposite material displayed both enhanced thermal conductivity and mechanical strength, quantified by tensile strength, impact toughness, and Young's Modulus. The nanocomposite material's mechanical properties increased with increasing concentration of graphene until it peaked at 5%, then began to decrease. Thermal conductivity increased approximately linearly with increasing graphene concentration. Our study shows an interesting interaction between graphene nanoparticles and polyethylene's polymer matrix, which could pave the way for a deeper understanding of how particles behave in a polymer matrix in general. A nanocomposite material which has enhanced thermal conductivity while maintaining mechanical stability could lead to a viable formulation of a polymer alternative to the traditional metal-alloy heat exchanger.