Graphene Solar-Photon Sail: A Novel Approach to the Application of Monolayer Graphene on Aluminumized Polyimide Film Using a Figure of Merit of a Solar-Photon Sail Membrane for Interstellar Space Exploration

Barkhurst, Morgan (School: Florida SouthWestern Collegiate High School - Lee Campus)

Graphene is a one atom thick monolayer hexagonal lattice of carbon atoms with a theoretical thickness of 0.345 nanometers and unique tensile strength capabilities. This study aims to determine how monolayer graphene can be utilized with an aluminumized polyimide film to improve the merit of a solar-photon sail membrane. If graphene is implemented, then the merit of the sail membrane will improve as compared to the isolated polyimide film because fewer cables would be needed, resulting in less mass. Monolayer graphene sheets were transferred to polyimide samples and tested for reflectivity and emissivity. The reflectivity was enhanced by graphene and compensated for losses in reflectivity caused by the transfer process. Emissivity values had a logarithmic relationship to temperature on the infrared thermometer; they should have an inverse relationship. The data are variable and inconsistent, making the emissivity inconclusive, therefore the polyimide's known emissivity was used. The graphene samples had a significantly higher interstellar cruise velocity than the other groups at some of their high sail velocities, even using graphene's lowest possible velocity. Graphene's velocity is likely between 6,300 and 19,000 m/s, greater than velocities of the samples without graphene, supporting the conclusion graphene improves solar-photon sail membranes. Graphene's ultimate tensile strength is 1,000 times the strength of the polyimide. Tensile strength should be considered in the figure of merit in future research. This study aims to pioneer the application of graphene for interstellar space exploration and spark future discoveries, discussions, and inventions involving this unique and promising material.

Awards Won:

NASA: Honorable Mention