Analysis of Manufacturing Process of D-Glucose-Based Thermoformed-Polymers

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This project analyzes the manufacturing and polymerization process in creating a stable polymer based upon the monomer D-Glucose. The purpose was to assess whether changes to the materials and the polymerization procedure would increase the overall tensile strength in series of recycling through heat reformations. Polymer samples were created by changing ingredient proportions of starch, hydrochloric acid, and polyethylene – oxide and dried in a lab. Each sample was examined to mark polymer orientation and cut into dumbbell shapes parallel to striations, which conform to ASTM standards. Tensile strength tests were conducted to measure properties like stress as a function of strain over a set period of time. Using force probes, increases to proportions showed an increase in overall strength that could be maintained and improved after re-melting through heat. Some polymers were able to be thermoformed properly, while the ones with little or no HCl failed to be thoroughly recycled without caramelizing. The inclusion of PEO composite increased the overall strength further. Variations in tensile strength tests suggested that as materials reform due to heat, bonds within become less stable and less durable. Using higher proportions of hydrochloric acid and PEO resulted in greater overall tensile strength after six periods of recycling. Properties of this polymer can be benchmarked with other commonly used plastics to establish real world applications. This includes the majority of consumer goods produced with plastic but also durable building materials and compliant mechanisms.

Awards Won:
Air Force Research Laboratory on behalf of the United States Air Force: First Award of $750 in each Intel ISEF Category
Second Award of $1,500