Overview

Our research concerns processing-structure-property relationships of polymers and composites. Specifically, we design processing strategies to attain hierarchical structures in these materials to improve properties and have discovered scalable processing methods to produce unusual structures.

Decontamination of Elastomers in Personal Protective Equipment

Much personal protective equipment (PPE) is designed to be used once and then disposed of; however, the recent pandemic and the associated medical supply shortages have caused medical professionals to consider reuse strategies for PPE. In this project, we are investigating how different decontamination protocols affect the structure-property-performance relationships of elastomers such as those used in mask straps.

Polymeric Materials for Material Extrusion Additive Manufacturing

We are developing techniques to understand how to use semicrystalline polymers with material extrusion additive manufacturing (MEAM), specifically using capillary rheology, fast scanning calorimetry (FSC), robust design and simulation techniques so that issue associated with crystallization can be addressed.

Polymer Composites for Radiation Shielding

As part of the REVEALS Team at Georgia Tech, we are working to understand how polymer nanocomposites could be used to provide a level of radiation shielding for space applications. Our current work involves developing chemical modification strategies for graphene oxide that allow for successful incorporation into radiation-attenuating polymer matrices.

Polymer Composites and Coatings Containing Bio-Based Nanofibers

To improve the environmental stewardship of polymers/plastics, bio-based materials are being increasingly investigated as replacement materials or as additives to synthetic materials. In line with these efforts, we are investigating the use of nanocellulose and chitin nanofibers (ChNFs) in polymer composites. Both types of nanofibers are derived from renewable resources, with nanocellulose sourced from precursors such as trees, plants, and organisms and ChNFs sourced primarily from shellfish.

We are working with a variety of polymer matrices and processing techniques to understand how cellulose nanocrystals (CNCs, a type of nanocellulose) and ChNFs may be incorporated effectively for thermomechanical reinforcement and to discover new routes for processing these systems that exploit their inherent attributes.

Auxetic Behavior in Fibrous Structures

Materials with an auxetic response have a negative value of Poisson’s ratio or similar behavior beyond the elastic regime. Auxetic behavior is not commonly seen in either natural or synthetic materials, and hence it offers possibilities for unique applications.

We are studying the auxetic behavior of paper and non-woven fabrics made from polyester or wool to understand what materials and processing variables impact the magnitude of this response.

Membranes for Concentration of Black Liquor

Graphene oxide is being used to form new membranes that will withstand the high pH (~12), temperature (90°C), and potential fouling species, present in spent pulping liquor (black liquor) leaving the digester in kraft pulp mills.

Acknowledgements

This work was supported by the NASA Solar System Exploration Research Virtual Institute, the National Science Foundation, the DOE-RAPID Institute, the USDA Forest Products Laboratory, P3Nano, the Renewable Bioproducts Institute at Georgia Tech, and industry sponsors.