DE-FOA-0002245
Summary for Public Release

Control number: 2245-1617

Degradable, Bio-functional Thermoplastic Polyurethanes

Jonathan K. Pokorski (PI), Adam Feist (Co-PI)
University of California San Diego

Jason Locklin (Co-PI)
University of Georgia

Md Arifur Rahman (Co-PI), Xuqiu Tan (Co-PI), Dave Wernick (Co-PI)
BASF Corporation

The proposed work describes the incorporation of microbial spores into thermoplastic polyurethanes (TPU) to form biofunctional composite materials. The microbial spore will serve as a functional filler, but more importantly as catalysts to promote biodegradation at the end of the composite material's lifecycle. The non-pathogenic microbial strain enrichment strategy along with metabolic pathway engineering will be utilized to enhance degradation and improve TPU breakdown. Active spores are uniquely positioned as bio-based fillers for TPU materials because they are exceptionally stable to the temperature and harsh chemical conditions needed for processing into biocomposite materials for end use applications. Furthermore, a diverse range of microbial spores, once activated, can degrade both polyether- and polyester-based TPUs. Lastly, spores are well characterized for their material properties and behave in a similar fashion to micron-scale rubber particles. The material properties of spores present the opportunity for spores to serve a functional filler for TPU to enhance toughening behavior. TPU expertise of BASF synergizes with that of researchers at UCSD, and UGA to provide a complete team for biocomposite fabrication, evaluation, and biodegradation. PI Prof. Pokorski at UCSD has developed pilot-scale equipment to rapidly evaluate melt-processed biocomposites for stability and activity – he will act in synergy with Rahman (BASF), Tan (BASF) and Feist (UCSD) to select and evaluate bacterial spores for incorporation. Once active biocomposites are generated, BASF and UGA will scale up and characterize materials properties and determine biodegradation protocols, respectively. Lastly, Feist will further optimize bacterial strains to accelerate degradation and improve breakdown byproducts of the degradation process. If successful, the team will have identified a first-of-its-kind biofunctional and biodegradable TPU. Upon the success of this research, the proposed materials could be immediately integrated into the supply chain and translated to end-use biodegradable products with negligible disruption in materials fabrication. Additionally, this new technology would be transformative to the chemical industry by increasing industrial resource efficiencies and providing sustainable solutions to conventional polymer and plastics based products.