Summary/Abstract for Public Release

Applicant: Case Western Reserve University (CWRU)
Principal Investigator (PI): Dr. João Maia
Project Title: Hybrid Chemical-Mechanical Separation & Upcycling of Mixed Plastic Waste

This project proposes to develop a novel hybrid chemical-mechanical technology for recycling and upcycling of laminated and multilayered plastics based on the paradigm-shifting hypothesis of continuous separation and post-separation recycling of the mixed, non-separated melt stream. Critical to that success will be use of a new twin-screw extrusion technology for continuous separation of materials in the melt and the modification of current recycling technologies, in particular catalytic cracking for PE and glycolysis and hydrolysis for PET, to extrusion. Multi-scale computational modeling will be integrated with the chemical and processing studies to inform the latter on optimal catalytic and degradation routes, microstructure development and rheological behavior, and process kinetics and optimization. A Life Cycle Analysis (LCA) will collect and establish a life cycle inventory of the hybrid recycling technology and provide an environmental impact assessment. At project end, PET and Nylon separation and upcycling will be achieved with industrial and domestic waste at pre-production scale (TRL 6) and polyolefin upcycling will be achieved in industrial setting at pilot scale with industrial and domestic waste (TRL 6).

The proposed technology is expected to allow similar levels of materials to be recycled when compared to chemical recycling, but be up to 70% cheaper to implement and provide at least 50% energy savings, especially for polyolefins, because the catalytic cracking process will be performed at much lower temperatures (approximately 300-350 °C by comparison with 450+ °C for pyrolysis in chemical recycling). Compared to mechanical recycling, the technology will have similar costs and energy consumption, but will allow the recovery of up to more than 80% by mass of the polymers, whereas mechanical recycling does not recover/upcycle any polymer. The TRL is expected to advance from 2 to 6.

Major Participants:

- Lawrence Livermore National Laboratory (LLNL)
- Sandia National Laboratories (Sandia)
- Braskem USA
- P&G
- Resource Material Handling and Recycling