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Project Summary

Project Title: A closed loop upcycling of single-use plastic films to biodegradable polymers

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The goal of this proposed project is to develop a novel plasma-biological hybrid technology to upcycle mixed single use flexible plastic film (SUPF) wastes into biodegradable polyhydroxyalkanoates (PHAs) using a circular carbon approach. The detailed objectives to achieve this goal include: (1) characterize SUPF containing mixed waste streams from Material Recovery Facilities (MRFs) to understand plastic feedstock variability; (2) innovate industry protocol of film recycling to obtain decontaminated SUPFs primarily comprising polyolefins; (3) use low-temperature plasma and CO_2 to produce fermentable intermediate liquid from the decontaminated SUPF wastes; (4) biosynthesize PHAs from the SUPF-derived intermediates to increase conversion efficiency and improve PHA recovery; (5) employ technoeconomic analysis and life cycle analysis modeling to determine process economics and environmental impacts of the proposed technology.

A successful completion of the project will enable an innovative plasma, and biological hybrid process to convert waste plastic film to biodegradable polymers with reduced energy inputs, carbon emissions, and production costs. An economically viable plastic wastes-to-PHAs leveraging waste CO_2 as a carbon source will advance and innovate the incumbent state-of-the-art technologies for plastic recycling/upcycling and PHA production. The project will be of interest to stakeholders in various sectors, such as waste management industries, polymer manufacturers, polymer users, as well as renewable energy industries. The research outcome of the project will also advance scientific understanding and deliver new knowledge in multidisciplinary fields. Overall, upcycling plastic wastes meant for landfills into low-cost biodegradable plastics via a circulated carbon approach provides a straightforward solution to the challenging problems caused by the increased production of petroleum-based plastics and their disposals, utilizing waste CO_2 at the point source.