SUMMARY FOR PUBLIC RELEASE

Project Title: Production of high-performance biodegradable polyurethane products made from algae precursors

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For algae-derived biofuels to be cost-competitive with fossil fuels, the algae industry is investing in the production of secondary high-value products and markets, including algae-based polymers. At the University of California San Diego (UCSD), we are developing sustainable and biodegradable algae-based polyurethane materials to meet this demand for increased value from algal biomass production, and address the increasing plastic waste problem.

In collaboration with Algenesis Materials, we have developed algae-derived polyurethanes used to generate products, including surf boards, flip flops, and athletic shoe midsoles, that contain up to 50% bio-based content and meet or exceed commercial performance metrics. Some of these products are already commercially available. Because these bio-based polyester polyurethanes have chemical bonds that occur in nature, the resulting products are biodegradable. We have identified that they degrade at approximately 3 – 4% per month in natural environments, such as residential compost piles.

In order to enable a non-linear plastic economy that can develop around algae-based polyurethane materials, our primary project goal is to develop a >80% bio-based polyurethane product that is biodegradable and has enhanced performance properties. To accomplish this, we propose to: 1) characterize the kinetics and products of biodegradation of our polyurethane foams to demonstrate that they biodegrade to non-toxic components; 2) increase the bio-based content of the polyurethane products by developing new bio-based diisocyanates, a key reactant for producing polyurethane foams, coatings, and adhesives; 3) demonstrate the capacity to scale production these monomers from algal biomass; 4) enhance the performance properties and quantify biodegradability of the polyurethane products through development of novel algal-derived diisocyanate and polyol products; and 5) in collaboration with the Kendall group at UC Davis, assess the environmental and economic potential for these biodegradable and recyclable algae-based polyurethanes.

A significant impact of this project will be the development of commercially-relevant technologies and characterization methodologies to enable the economically viable production of nearly 100% bio-based polyurethanes that are biodegradable. The ability to degrade these foams and not produce toxic byproducts means that they will not accumulate in the environment like the vast majority of petroleum-based plastics.

Key project partners include UCSD, UC Davis, and Algenesis Materials. These efforts will also be supported by cost share partners, Algenesis Materials, PepsiCo, BASF, and REEF, each of whom have direct stakes in the outcomes of this project. Algenesis Materials seeks to commercialize these polyurethane products, while BASF, REEF, and PepsiCo are potential consumers of these polyurethanes and polyurethane precursor materials for the production of industrial chemicals, leisure wear, and food packaging, respectively.