Project Title: Production of Bioproducts from Electrochemically-Generated C1 Intermediates

Waste CO_2 streams are generated by a variety of industrial processes, some examples being steel production and power generation. Biofuel production processes can also emit these streams and in the U.S., the majority come from corn ethanol production. The objective of this project is convert a waste CO_2 stream into an isopropanol (IPA) bioproduct, with a minimum conversion efficiency of 37%. The CO_2 will first be converted into CO using electrolysis, which will then be converted to IPA using LanzaTech's gas fermentation technology. The minimum conversion efficiency will be met in two ways, increasing the IPA productivity during fermentation and recycling of exhaust CO_2 from the fermentation reactor back through the electrolyzer. LanzaTech has recently discovered that feeding arginine to acetogenic bacteria such as *C. autoethanogenum* boosts ATP availability, resulting in higher productivity. Computational modeling will determine which *C. autoethanogenum* strains may have the highest yield increase. Promising strains will be genetically modified to enable arginine uptake in the presence of CO, and reduce byproduct formation to maximize conversion to IPA. Arginine also has the added benefit of acting as a nitrogen source and eliminating the need for fossil ammonia during fermentation. The electrolyzer will be enhanced for robustness and scalability.

Our project combines an innovative strategy for strain development that if successful will provide energetic advantages for microbial physiology in the concept of an integrated system for recycling CO_2 into IPA. Genetically modifying the microbe to grow on arginine could potentially increase the yield of longer chain molecules for gas fermentation of acetogenic bacteria and provide economically viable pathways for their production. Enhancing the electrolyzer for robustness and scalability will lower the overall cost of the electrolysis technology. Integration of electrolyzer and fermentation technologies using CO_2 as feedstock will support testing of different microbial strains for renewable fuels and chemicals in the future.

The collaborative project team consists of engineers and scientists from LanzaTech, Dioxide Materials, and Argonne National Laboratory. Dr. Christophe Mihalcea and Dr. Michael Köpke from LanzaTech will act as co-leads of the project, and will lead the fermentation and synthetic biology efforts, respectively. Dr. Rich Masel from Dioxide Materials will lead the effort on electrolyzer enhancements, while Dr. Pahola Thathiana Benavides from Argonne will lead the evaluation of environmental impact of the process.