Applying Innovation to Consumer Products – A New Carbon Economy for a Blue-Sky Future

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Introduction of research

The world today has an abundancy of carbon rich waste, including, for example, industrial off-gas, municipal solid and plastic wastes, biomass, and agricultural waste. In order to meet United Nation's Sustainable Development Goals (SDGs), including a 30% reduction in absolute CO_2 emissions by 2030, we need to embrace all solutions available and transition to a new carbon economy. Taking advantage of carbon recycling provides the chance to turn a potential liability into an opportunity with economic benefits. This presentation will discuss how carbon capture and use can lead to innovative products with a lower carbon footprint compared to fossil- sourced alternatives.

Body

Carbon capture and utilization technology captures and utilizes carbons derived from different waste streams and converts them into everyday consumer goods and fuels. This technology can be applied to a variety of industries and sectors, including many of the difficult to decarbonize sectors of steel, plastics, and aviation. LanzaTech's technology is based on a gas fermentation process. Gas fermentation uses a living, naturally occurring organism to ferment gases to make fuels—such as ethanol—and chemicals, similar to the traditional fermentation of sugars to make alcohol, where yeast eats sugars to make beer. The LanzaTech process converts carbon-rich gas streams to valuable products using its proprietary microbes that feed on gases (rather than sugars, as in traditional fermentation). The robustness of the microbial system enables it to use a variety of point-sourced, nonfood, low-cost, and highly abundant feedstocks.

The microbe used in the process occurs naturally and has been optimized to economically produce ethanol and enable economic routes to jet fuel and high-value chemicals from a variety of carbon-rich gas streams, such as:

- industrial off-gases from steel and ferroalloy mills
- petroleum refineries, petrochemical complexes, and gas processing facilities
- syngas generated from any biomass resource, including municipal solid waste, organic industrial waste, and agricultural waste
- reformed biogas and landfill gas
- CO_2 off-gas from biorefineries, or directly captured from the atmosphere

Examples, using the LanzaTech process, include carbon that has been a part of the chemistry of steelmaking that then is recycled into ethanol, which can in turn be converted into aviation fuel or other chemicals. Through partnerships with consumer-facing companies such as Unilever, L'Oréal, lululemon, Coty, and the Mibelle Group, LanzaTech has been excited to demonstrate the opportunity to use ethanol as a platform CarbonSmart™ intermediate in the production of goods including fragrances, cleaning products, plastics for packaging, and fibers for clothing. By recycling carbon to make ethanol in this way, everyday products can show carbon reduction benefits. The development of a comprehensive synthetic biology capability for gas fermenting organisms has further enhanced this opportunity. Going forward the CarbonSmart concept will be applied to a range of chemical intermediates as gas fermentation organisms are precision engineered to make an array of novel chemicals from recycled carbon.

Conclusion

Gas fermentation has successfully been scaled up to utilize a variety of carbon rich feedstocks that are available in abundance. We have demonstrated that emissions from a steel-mill can be captured and used as a feedstock on a commercial scale, and ethanol derived from the process has been used either directly, or as an intermediate in the production of multiple consumer products, spanning from fragrances and cleaning products to plastic packaging and fibers for clothing.

About the speaker

Dr. Johanna Haggstrom is currently the Vice President, Chemicals and Hydrocarbon Fuels Technology, at LanzaTech. She leads the R&D efforts and is responsible for chemical and fuels technology products, processes, measurements and tools, project management, commercial engagement, quality, budget and organizational development.

Johanna is a Research & Development Executive with >19 years of experience conducting and overseeing product development and research. Dr. Haggstrom holds a Bachelor of Science in Chemical Engineering from Mälardalen University in Sweden and a PhD in Chemistry from Kansas State University, and she has contributed to more than 35 patents, patent applications and published papers. Dr. Haggstrom also co-authored a chapter on 'Environmental Stewardship' in the book 'Fracturing Horizontal Wells', published in 2016.