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POLLUTION TO PRODUCTS: RECYCLING OF "ABOVE GROUND" CARBON BY GAS FERMENTATION

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Climate crisis and rapid population growth are posing some of the most urgent challenges to mankind. The accelerating rate of extraction and combustion of fossil resources for fuel, energy and chemicals over the past 100 years has resulted in carbon dioxide (CO_2) accumulation in the atmosphere to levels unprecedented since the Pliocene Epoch (5.3 - 2.6 million years ago). Although the effect that elevated atmospheric CO_2 will have on the Earth's climate has been predicted by scientists for several decades, it was only in 2016 through the Paris Agreement that nations formally laid plans to abate atmospheric CO_2 release. In each case, these plans necessitate that "above ground" carbon resources increasingly displace fossil resources as feedstocks for fuel and chemical production.

Gas fermentation offers a solution using carbon-fixing chemolithoautotrophic microorganisms. After a decade of scale up, the technology has recently been commercialized with the first 48k MTA plant turning emissions from the steel industry into fuel ethanol operating successfully and additional units under construction. Through advancements in process technology and strain engineering, gas fermentation offers unique feedstock and product flexibility when compared to other available gas-to-liquid technologies, enabling a circular economy. The process can accept a broad range of feedstocks including waste gases from various industrial sources (e.g., processing plants or refineries) or syngas generated from any biomass resource (e.g., unsorted and non-recyclable municipal solid waste, agricultural waste, or organic industrial waste) and production of over 100 molecules have been demonstrated.

A decade ago, gas fermenting organisms were poorly understood, considered to be genetically inaccessible and mass-transfer of gases was perceived as a major scale up hurdle. LanzaTech has pioneered the development of genetic tools for gas fermenting acetogens and established an anaerobic biofoundry for fully-automated engineering and screening of strains in context of flammable and toxic CO and H_2 gases. Large scale datasets and multi-omics approaches have led to an improved understanding at the metabolic and molecular level and enabled the development of sophisticated models. Guided by these models, optimized production strains for synthesis of molecules like acetone, isopropanol or butanediol directly from gas at high titer, rate and yield have been developed and are currently scaled up for commercial rollout. Developed scalable reactor designs ensure efficient, continuous, single-pass gas conversion.