Carbon Capture and Utilisation

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The world is made of carbon. Not only all living matter is built from carbon molecules but also materials that make our modern life possible, like fuels, polymers, cosmetics, pharmaceuticals, and more. For most of human history, carbon cycled to and from the atmosphere, land, and ocean in rough balance. Since the 19th century, mankind has gathered carbon from long-dormant fossil resources (coal, oil, natural gas), and put it into the atmosphere, throwing off the balance. That buildup of CO_2 is the dominant cause of climate change, with increasingly catastrophic effects. As engineers, we must find alternatives to the emission of fossil carbon. However, carbon remains a useful building block for products and fuels, and fossil fuels remain an inexpensive source of stored energy.

The field of Carbon Capture, Utilization, and Storage (CCUS) seeks to solve challenge. Carbon capture is the separation of CO_2 from mixed gas streams, typically either from combustion flue gas or directly from the air ("direct air capture"). If captured fossil CO_2 is put back underground (carbon capture and storage), the energy from fossil fuel can be used without the climate impact. A similar effect can sometimes be achieved by capturing CO_2 and putting into long-lived materials (carbon capture and utilization). In the long term, we must achieve a circular economy by capturing the carbon we use for fuels and products from the air or from biological sources.

CCUS is a challenge both of large-scale engineering (gigatons of carbon must be captured in order to meet current climate goals) and multiple technology disciplines. For capture, improved materials and innovative process designs are needed to reduce the large energy demand capital cost of separating CO_2. For utilization, new synthesis routes from CO_2 and useful materials with high CO_2 content are needed. A major avenue of research in this regard is the development of catalysts that enable an efficient conversion of the unreactive CO_2 molecule. The scale up of these techniques and the integration of these new conversions in the existing industrial processes are the next challenge.

<u>Talks:</u>

The Refinery of Today, Tomorrow, and the Future: The Role of CO_2 *Capture*
Ryan Lively, Georgia Institute of Technology

Towards Novel, Scalable and Realizable Technologies for Carbon Capture, Utilization, and Storage: Hybrid Absorption-Crystallization Pathways for Inorganic and Organic Carbonate Synthesis and H_2 *Generation*
Greeshma Gadikota, Cornell University

Surface-sensitive Electrochemical CO_2 *Reduction Reaction*
Mehtap Oezaslan, TU Braunschweig

CO_2 *in New Materials*
Michael Weinkraut, Covestro AG