EPFL

SEMINAR SERIES

HIGHLIGHTS IN ENERGY RESEARCH

20.02.2020, 16:00 - 17:00, EPFL Valais, 4th floor, TSEUZIER room

Development and Deployment of Negative Emissions Technologies (NETs): Humanity's Moonshot for the 21st Century

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Worldwide energy demand is projected to grow strongly in the coming decades, with most of the growth in developing countries. Even with unprecedented growth rates in the development of renewable energy technologies such as solar, wind and bioenergy, the world will continue to rely on fossil fuels as the predominant energy source for at least the next several decades. Simultaneously, due to decades of inaction, most current climate models suggest that limiting warming to <2°C will require large scale deployment of negative emissions technologies (NETs). NETs, which remove CO2 from the atmosphere, are projected to be needed at a scale of 10 Gt/y by 2050, yet today, virtually none of been deployed.1 NETs may be natural or technological, with one of the most scalable technological approaches being the direct capture of CO2 from the air, or "direct air capture" (DAC).2 Because of the ultra-dilute nature of air, the separation of CO2 from this mixture presents a significant engineering challenge.

In this lecture, I will describe the design and synthesis, characterization and application of new supported amine materials that we have developed as cornerstones of new technologies for the removal of CO2 from dilute (flue gas) and ultra-dilute (air) gas streams.3 These chemisorbents efficiently remove CO2 from simulated flue gas streams, and the CO2 capacities are actually enhanced by the presence of water, unlike in the case of physisorbents such as zeolites. We will describe the development of these materials, how they integrate into scalable DAC technologies, as well as their key physicochemical structure-property relationships. DAC technologies offer an interesting case study for the parallel design of materials, unit operations, and processes in chemical engineering.

1. https://nas-sites.org/dels/studies/cdr/
2. "Direct Capture of CO_2 from Ambient Air." E. S. Sanz-Pérez, C. R. Murdock, S. A. Didas, C. W. Jones, *Chemical Reviews*, **2016**, 116, 11840-11876.
3. "Amine-Oxide Hybrid Materials for CO_2 Capture from Ambient Air." S. A. Didas, S. Choi, W. Chaikittisilp, C. W. Jones, *Accounts of Chemical Research*, **2015**, 48, 2680-2687.

Bio : Christopher W. Jones is the William R. McLain Chair and Professor of Chemical & Biomolecular Engineering at Georgia Tech. He previously served as Associate Vice President for Research from 2013-2019, including a period as Interim Executive Vice-President for Research in 2018.

Dr. Jones leads a research group that works in the broad areas of materials, catalysis and adsorption. He is known for his extensive and pioneering work on materials that extract CO_2 from ultra-dilute mixtures such as ambient air, which are key components of direct air capture (DAC) technologies. For the past decade, he has worked closely with Global Thermostat LLC on DAC technology development.

He also has produced extensive body of work in catalysis, including heterogeneous and homogeneous catalysis, spanning from asymmetric catalysis in organic synthesis (specialty synthesis) to conversion of syngas into higher alcohols (commodity production). Jones has published almost 300 peer-reviewed scholarly papers on catalysis and separations, and has mentored 100 MS, PhD and post-doctoral students over the past 20 years.

The American Chemical Society recognized Jones' catalysis research with the *Ipatieff Prize* in 2010, followed by the North American Catalysis Society with the *Paul H. Emmett Award in Fundamental Catalysis* in 2013. Dr. Jones is the founding Editor-in-Chief of the journal, *ACS Catalysis*, and is Vice-President of the North American Catalysis Society.

In 2016, he was recognized by the American Institute of Chemical Engineers for his work in catalysis and CO_2 capture with the *Andreas Acrivos Award for Professional Progress*.