Abstract

Organic/inorganic hybrids comprise a mixture of oxide particles and polymers, forming specific structures with unique functionalities. These materials have a wide range of potential applications in coatings, fuel cells, solar cells, and sensors. Organic amino (-NH2) silane-modified silicas are widely studied hybrid materials which have been used as thermal insulators and sorbents for CO2 capture. The NH2 functional group of this hybrid material binds CO2 through acid-base interactions. Our recent studies have revealed that the strength of acid-base interactions can be fine-tuned by polyethylene glycol, allowing CO2 to adsorb at temperatures below 55 C, and to desorb at 100 C. The differences in the CO2 adsorption and desorption temperature as well as the sorbent’s heat capacity govern the operating cost of the CO2 capture process. The key challenge in scaling up the process of amino silica is its long term stability. The low stability of amino sorbents could be due to the attack of reactive oxygen species on the C-H and N-H groups of the amino silica. Development of an effective and stable sorbent requires a fundamental understanding of CO2-O2-amine interactions. This presentation will review the basic and applied research of amine-silica hybrid materials, describe the approaches and results of studying CO2-O2-amine interactions, discuss the development of low cost pilot scale CO2 capture processes, and compare process economics of various post combustion CO2 capture approaches. This presentation will also briefly examine the current status of using organic/inorganic hybrids in fabrication of solid oxide fuel cells.

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Biosketch

Steven S. C. Chuang obtained his Ph.D. from University of Pittsburgh, 1985. He joined the University of Akron in 1986 and served as Chair of Chemical Engineering in 1977-2005. In 2010, he established the FirstEnergy Advance Research Center with a fund from FirstEnergy Corp, aiming at accelerated development of CO2 capture processes and Coal-based fuel cell. In 2011, he was appointed as Professor of Polymer Science and Director of Energy Materials Forum at the College of Polymer Science and Engineering at the University of Akron. Professor Chuang investigates the structure of adsorbed species and its reactivity by transient infrared (IR) techniques. These techniques combined with traditional characterization methods such as XRD, UV-Vis, NMR, SEM, and TEM have been used for studying the nature of adsorbed species during oxygenate synthesis, hydroformylation, partial oxidation, reduction of nitric oxide, nitric oxide decomposition, oxidative carbonylation, photocatalytic oxidation and reduction, carbon dioxide adsorption, and reactions on solid oxide fuel cell catalysts. The objectives of his research program are (i) developing an understanding of the reactivity of adsorbed species and its associated sites, (ii) using mechanism information to guide catalyst and sorbent preparation, and (iii) scaling up of catalytic and separation processes from laboratory scale to the pilot scale.