**CO2-Pmerselective Membrane Reactors for Hydrogen Production with CarbonCapture**

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Hydrogen is primarily produced from natural gas requiring costly separation of CO2 and H2 in the product stream. Many studies have been reported on using hydrogen-selective inorganic membrane reactors for conversion of natural gas with in-situ hydrogen separation. One of the major problems with such membrane reactors is that hydrogen is produced at low pressure and needs to be repressurized for industrial applications. Our laboratory pioneered dense ceramic-carbonate dual-phase membranes consisting of an oxygen-ionic or mixed-conducting ceramic phase and a molten carbonate phase. At high temperature (>500oC), carbon dioxide (CO2) can transport as carbonate ion through the carbonate phase under the driving force of the CO2 partial pressure gradient, balanced by the counter-direction transport of oxygen ions in the ceramic phase. This paper will provide an overview and experimental results of the applications of this group of membranes perm-selective to CO2 in catalytic membrane reactors for hydrogen production with in-situ CO2 capture (addition or removal). The talk will show that when coupled with reactions involving methane or CO, the ceramic-carbonate dual-phase membrane reactor can effectively convert methane or CO to hydrogen with in-situ separation or capture of CO2. The membrane reactors provide enhanced conversion beyond the equilibrium limit, producing high purity H2 at high pressure with CO2 capture from the flue gas or product stream. The effectiveness of the membrane is improved significantly with high pressure feed. For water gas shift reaction, this membrane reactor can achieve CO conversion larger than 95% producing the H2 and CO2 streams of sufficiently high purity in a single stage. Techno-economic analysis shows that the membrane reactor process for water gas shift reaction offers about 5-fold reduction in operation costs as compared to the conventional process of fixed-bed reactors followed by energy intensive amine-based CO2 separation.

**Biosketch**

Jerry Y.S. Lin is a Regents’ Professor at Arizona State University. He was department chair of chemical engineering at ASU from 2006-2009 after his 13-year appointment as a faculty member at University of Cincinnati. Dr. Lin’s main research areas are membrane science, adsorption/catalysis, and energy storage. He has published about 400 papers mostly in chemical engineering journals, and is an inventor of 9 US and European patents, and was listed as one of most cited authors in the field of chemical engineering. Dr. Lin received several awards including AIChE Institute Award for Excellence in Industrial Gas Technologies in 2009 and AIChE Gerhold Award in 2021. He is an elected fellow of American Society for Advancement of Science (AAAS), American Institute of Chemical Engineers (AIChE) and North American Membrane Society (NAMS). Dr. Lin was an Editor of Journal of Membrane Science for 12 years, and is currently the co-Editor-in-Chief of Journal of Membrane Science and JMS Letters.