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Development of new bi-functional dense ceramic-carbonate membrane reactors for CO oxidation and subsequent CO_2 permeation

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Gas separation processes have become one of the most promising strategies for different industrial applications; carbon dioxide (CO_2) and carbon monoxide (CO) separation among them. Within this context, syngas is composed of hydrogen and carbon oxides, and it is usually produced at high temperatures. Therefore, H_2 enrichment, through the carbon oxides separation is of great interest. On CO_2 separation, different membrane systems have been developed, including zeolites, polymers, and ceramics. Especially, the so-called dense dual-phase membranes have shown very interestingly CO_2 separation properties at high temperatures. This kind of membrane systems is produced by a porous solid support infiltrated with molten carbonates, where ceramic supports must ideally have oxygen ionic and electronic conductive properties. CO_2 permeation is performed by the reaction of oxygen ions from the ceramic oxide with the CO_2 present on the upstream side, producing carbonate ions, which diffuse through the molten carbonate phase due to CO_2 partial pressure gradients on both membrane sides. CO_2 is desorbed on the downstream side through the reversible decarbonation process and swept from the surface. Oxygen ions are reincorporated and diffused on the ceramic phase as a consequence of decarbonization. Since perovskites have good ionic-electronic conduction properties, some of them have been incorporated to dense ceramic-carbonate membranes, increasing CO_2 permeation. In this work, a composite (doped ceria and perovskite) was synthesized, sintered and infiltrated with molten carbonates, showing that it is able to perform both processes; the CO oxidation at the surface and subsequent CO_2 permeation through the molten carbonate phase. CO conversion and CO_2 recovery efficiencies were 39.6 and 64.6% at 900 °C, respectively. Moreover, results in evidence that the perovskite phase importantly improve the oxygen permeation from sweep to feed side (inverse permeation), enhancing CO oxidation and CO_3^{2-}formation, without releasing oxygen on the feed side.

Biography

Pedro Sanchez-Camacho received a Chemistry´s degree from the Universidad Nacional Autónoma de Mexico (UNAM) in 2012. Later, he obtained a master´s degree in Material Science and Engineering in same University. Nowadays, he studies a PhD in a Materials Science and Engineering focusing in the development of ceramic oxide membranes in order to separate CO2 from a gas mixture. He is especially interested in solid state chemistry, ceramic synthesis, sorption processes on ceramics, catalysis, inorganic membranes for gas separation and solid oxide fuel cells (SOFC´s). As part of his work, some papers have been published on referred journals such as Journal of Physical Chemistry and Journal of Energy Chemistry, among others.

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