Inorganic membranes for gas and liquid processing

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Integrating inorganic membranes into industrial separation processes has many advantages including high temperature operation, thus reducing the need to cool down gases and improving overall process efficiency. In the gas separation field, ceramic membranes can process gas streams containing hydrogen or oxygen, which are two major world commodities for petrochemical and energy applications. Hydrogen can be separated by metal oxide silica derived membranes, a molecular diffusion controlled process leading to temperature dependence activated transport. Oxygen can be separated by dense perovskite membranes, where the design and doping of the crystal cubic structure can increase the number of oxygen defects, thus increasing the diffusion of oxygen ions by a hopping mechanism. In addition, inorganic membranes are now closing the performance gap in desalination applications, whilst vacuum can be used to tailor the pore size of carbon derived membranes. This work presents the latest development in conventional and novel rapid thermal processing (RTP) of silica derived membranes, perovskite membranes, carbon membranes, and inorganic mixed matrix membranes (MMM) containing carbon/alumina phases, or catalytic/perovskite phases. This work also shows the scale up and 2000 hours testing performance of a membrane module containing 8 membrane tubes in four parallel lines for single gas and binary gas mixtures up to 500°C. Finally, the future challenges of ceramic membranes are discussed.

Biosketch.

Joe DA COSTA is the Director of the FIM2Lab *"Functional and Interfacial Materials and Membrane Laboratory"*, and a Professor in the School of Chemical Engineering at the University of Queensland, Brisbane, Australia. Currently he holds a Future Fellowship from the Australian Research Council. Joe has over 30 years working experience in industrial, consultancy and academic roles in Brazil, England and Australia. Currently, he leads several research projects in the area of H_2, CO_2, O_2, ethanol separation and desalination using inorganic membranes and membrane reactors. His research is directed towards the application of clean energy delivery by applying the principles of functional nanotechnology to fabricate high quality membranes. The focus of his work is providing engineering solutions to real industrial applications. Joe has over 250 international publications including 13 book chapters on membranes and membrane reactors, a H-index of 37 and several patents. He is a Chartered Professional Engineer in the Colleges of Mechanical Engineering and Chemical Engineering of the Institution of Engineers Australia.