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ABSTRACT:

Intensified Catalytic Reactors Based Solid-State Membranes

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The gas exchange, diffusive and catalytic pathways on the surface of intensified membrane reactors usually determine the evolution rate, the selectivity towards target reaction products, and the system's stability. Solid-state ionic materials are crucial for modern energy technologies, such as fuel cells, batteries, and electrolyzers. The use of these applications is not limited to the aforementioned areas; rather, they are gaining significance in the process industry. These materials are key for reducing CO2 emissions and electrifying industrial processes. Electrochemical solid-electrolyte systems enable to shift chemical equilibria within the catalytic reactor in a favorable direction and facilitate the in-situ separation of valuable products. Novel reactor concepts involve using microwaves and ceramic ion-conducting cells to electrochemically drive catalytic reactors, requiring selective electrocatalysts with adjusted diffusive and catalytic properties to produce specific gas products. For instance, protonic membrane reactors employing ceramic proton conductors like doped BaZrO3 show high chemical stability in carbon-rich environments and excellent proton conductivity, enabling the integration of catalytic reactions and separation in a

single step, yielding pressurized H_2. These innovations improve per-pass yield, energy efficiency, and catalyst stability, advancing process intensification and sustainability.