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Influence of La0.1Sr0.9Co1-xFexO3-δ Catalysts on Oxygen Permeation Using Mixed Conductor

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Abstract : The separation of oxygen is one key technology to improve the efficiency and to reduce the cost for the processed of the partial oxidation of the methane and the condensation of the carbon dioxide. Particularly, carbon dioxide at high concentration would be obtained by the combustion using pure oxygen separated from air. However, the oxygen separation process occupied the large part of energy consumption. Therefore, it is considered that the membrane technologies enable to separation at lower cost and lower energy consumption than conventional methods. In this study, it is examined that the separation of oxygen using membranes of mixed conductors. Oxygen permeation through the membrane is occurred by the following three processes. At first, the oxygen molecules dissociate into oxygen ion at feed side of the membrane, subsequently, oxygen ions diffuse in the membrane. Finally, oxygen ions recombine to form the oxygen molecule. Therefore, it is expected that the membrane of thickness and material, or catalysts of the dissociation and recombination affect the membrane performance. However, there is little article about catalysts for the dissociation and recombination. We confirmed the performance of La0.6Sr0.4Co1.0O3-δ (LSC) based catalyst which was commonly used as the dissociation and recombination. It is known that the adsorbed amount of oxygen increase with the increase of doped Fe content in B site of LSC. We prepared the catalysts of La0.1Sr0.9Co0.9Fe0.1O3-δ(C9F1), La0.1Sr0.9Co0.5Fe0.5O3-δ(C5F5) and La0.1Sr0.9Co0.3Fe0.7O3-δ(C7F3). Also, we used Pr2NiO4 type mixed conductor as a membrane material. (Pr0.9La0.1)2(Ni0.74Cu0.21Ga0.05)O4+δ(PLNCG) shows the high oxygen permeability and the stability against carbon dioxide. Oxygen permeation experiments were carried out using a homemade apparatus at 850 -975 °C. The membrane was sealed with Pyrex glass at both end of the outside dense alumina tubes. To measure the oxygen permeation rate, air was fed to the film side at 50 ml min-1, helium as the sweep gas and reference gas was fed at 20 ml min-1. The flow rates of the sweep gas and the gas permeated through the membrane were measured using flow meter and the gas concentrations were determined using a gas chromatograph. Then, the permeance of the oxygen was determined using the flow rate and the concentration of the gas on the permeate side of the membrane. The increase of oxygen permeation was observed with increasing temperature. It is considered that this is due to the catalytic activities are increased with increasing temperature. Another reason is the increase of oxygen diffusivity in the bulk of membrane. The oxygen permeation rate is improved by using catalyst of LSC or LSCF. The oxygen permeation rate of membrane with LSCF showed higher than that of membrane with LSC. Furthermore, in LSCF catalysts, oxygen permeation rate increased with the increase of the doped amount of Fe. It is considered that this is caused by the increased of adsorbed amount of oxygen.

Keywords : membrane separation, oxygen permeation, K2NiF4-type structure, mixed conductor
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