Oxygen permeation characteristics of zirconia with surface modification

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Abstract

Oxygen permeation membrane can be used for the separation of industrial gases such as oxygen and hydrogen, or for the deoxidization of steel melt at high temperature. The mechanical and the chemical stability are required for the uses. The Yttria-Stabilized-Zirconia (YSZ) is a candidate for the applications due to its stability at high temperature and in reduced oxygen partial pressure (Po2). The oxygen flux of YSZ was measured as a function of the temperature (¿1500oC) and Po2 (3x10-12 2x10-8 atm). The Po2 values of both feed and permeate sides were controlled by mixing CO and CO2 gases and measured by oxygen sensor. The oxygen flux, driven by an oxygen chemical potential gradient, was determined by the change in CO2 content in permeate side. The CO2 content was measured by gas chromatography. The measured oxygen permeability was smaller than the value estimated from the reported electrical conductivity. Thus, the observation tells us that the oxygen permeation was mostly limited by the surface oxygen exchange kinetics in spite of very high temperature. The modification of YSZ surface with porous coating layer was considered as one method for increasing the oxygen flux. Ceria or ceria-YSZ mixture was coated on YSZ and the resultant flux was measured and compared with that without coating layer. With ceria coating, the oxygen flux of YSZ drastically increased, nearly 8 times. However, the increased flux was not maintained for long time. The flux was related with the mixed conductivity and microstructure.