Oxygen and carbon dioxide separation membranes based on mixed conductors

Hitoshi Takamura
Tohoku University, takamura@material.tohoku.ac.jp

Follow this and additional works at: http://dc.engconfintl.org/composites_all

Part of the Materials Science and Engineering Commons

Recommended Citation

This Conference Proceeding is brought to you for free and open access by the Proceedings at ECI Digital Archives. It has been accepted for inclusion in Composites at Lake Louise (CALL 2015) by an authorized administrator of ECI Digital Archives. For more information, please contact franco@bepress.com.
OXYGEN AND CARBON DIOXIDE SEPARATION MEMBRANES BASED ON MIXED CONDUCTORS

Hitoshi Takamura,
Department of Materials Science, Graduate School of Engineering, Tohoku University, Sendai 980-8579, Japan
takamura@material.tohoku.ac.jp

Key Words: Oxygen separation, CO₂ separation, Mixed conductors, Porous body

Gas separation is one of the key technologies to improve the efficiency of combustion process, and to reduce the emission of global warming gases. By using pure or concentrated oxygen, flame temperature governing the Carnot efficiency and the concentration of CO₂ in exhaust gas can be raised. Among a number of oxygen separation techniques such as cryogenic separation, oxygen separation membranes based on mixed oxide-ion and electronic conductors have been attracting much attention because of its high selectivity (100% in principle) and the ease of integration into various combustion systems. Figure 1(a) shows how the oxygen separation membrane works; only oxygen can penetrate as a result of ambipolar diffusion of oxide ions and electrons caused by an oxygen potential gradient. To date, a number of oxygen separation membranes such as perovskite-type oxides and dual-phase-type composites containing transition metals have been developed; however, to use the membranes in the expected applications, oxygen permeation flux governed by surface exchange kinetics and the tolerance of CO₂, which is a main constituent of exhaust gas, need to be further improved. Recently, our group has succeeded in improving the oxygen permeation flux of Ba-Sr-Co-Fe-based oxygen separation membranes by surface modification using a porous body [1]. In which, weight relaxation performed at 400 °C revealed the enhancement of the surface exchange reaction. The chemical surface exchange coefficient (kₘₑₐ) was 3.1 times larger for the sample with the porous body coating. A technique to further increase the oxygen flux will be discussed. In addition, how the CO₂ tolerance of Ba-Sr-Co-Fe-based oxides can be managed will be presented.

As well as oxygen separation, CO₂ separation is of great interest in the context of CO₂ capture and storage. As an analogous application using mixed conduction, CO₂ separation membranes has been studied [2]. In this case, as shown in Fig. 1(b), the mixed conduction of oxide ions and carbonate ions plays a key role. In this study, a composite material comprising Sm-doped CeO₂ and molten carbonates was prepared. The composite was found to permeate CO₂ at around 900°C. The CO₂ permeation flux was investigated with respect to its microstructure and electrical conductivity.

References

Figure 1 – Principles of (a) oxygen separation and (b) CO₂ separation membranes based on mixed conduction.