A Novel Method for Obtaining Carbon Molecular Sieves for N_2/O_2 Separation

Koki Urita[1], Kaito Marubayashi[1], Miyu Hamasaki[1], Hideki Tanaka[2], Takashi Ishida[3], Yasuyuki Yamane[3], Jin Miyawaki[4], Hiroo Notohara[1], Isamu Moriguchi[1]

[1] Department of Engineering, Nagasaki University, 1-14 Bunkyomachi, Nagasaki 852-8521, Japan
[2] Research Initiative for Supra-Materials (RISM), Shinshu University, 4-17-1 Wakasato, Nagano 380-8553, Japan
[3] Research & Development Dept., Activated Carbon Business Div., Osaka Gas Chemicals Co., Ltd., 5-11-61, Torishima, Konohana-ku, Osaka, 554-0051, Japan
[4] Institute for Materials Chemistry and Engineering, Kyushu University, 6-1 KasugaKoen, Kasuga, Fukoka 816-8580, Japan
email for correspondence: urita@nagasaki-u.ac.jp

The use of oxygen-enriched air with high oxygen concentration is expected to reduce fuel consumption in industrial furnaces. The pressure swing adsorption method was used for the air separation. However, temperature swing adsorption (TSA) using combustion exhaust heat is expected to save more energy. To achieve highly efficient air separation by introducing TSA, a molecular sieve adsorbent whose pore entrance diameter is optimized for preferential adsorption of oxygen is required [1]. Because the electrochemical oxidation (ECO) process adds oxygen-containing functional groups (OCFGs) to carbon materials [2], ECO can be expected to narrow the pore entrance. ECO is usually performed using block carbon electrodes obtained by mixing with a binder. On the other hand, a flow-type ECO is operated by pumping the suspension into the electric field using a suspension of the electrolyte and carbon materials. In this study, we examined the conditions for the addition of OCFG to porous carbons by flow-type ECO and aimed to create a molecular sieving carbon with oxygen/nitrogen selectivity. XPS analysis indicated that the oxygen content on the carbon surface was increased by ECO, and the addition of OCFGs to the porous carbon surface is possible in the flow-type ECO method even though the carbon electrode is not fixed on a current collector. O_2 adsorption isotherms at 20 °C and 80 °C showed that effective O_2 adsorption was decreased in the ECO-treated samples. The decrease in the adsorbed amount should stem from partial pore occlusion and pore size reduction by the addition of OCFGs to the pores. However, by comparing the adsorption time required to reach the adsorbed amount to half the equilibrium adsorption amount before and after ECO treatment, it was found that the adsorption rate of N_2 was significantly reduced by the ECO treatment. These results suggest that the addition of OCFGs to the pore entrance of porous carbon by ECO is effective for the fabrication of carbon molecular sieves for oxygen/nitrogen separation.

References:

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