# Study on Cathode Material for Intermediate Temperature CO_2 Electrolysis by Using LaGaO_3 Electrolyte

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論文題名：

Study on Cathode Material for Intermediate Temperature $CO_2$ electrolysis by Using $LaGaO_3$ Electrolyte

($LaGaO_3$ 系固体電解質を用いる $CO_2$ の中温電解のためのカソード触媒に関する研究)

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論文の要約のデータ:

Solid oxide electrolysis cells (SOECs) for converting $CO_2$ to more useful chemical species are attracting considerable attention because of their high electrolytic efficiency, offering the possibility of direct conversion of $CO_2$ to CO ($CO_2 \rightarrow CO + 1/2O_2$). Heat energy supplied to SOECs can maximize electrolysis efficiency, offering both thermodynamic and kinetic advantages. The generated CO can be used as a fuel gas, converted into syngas via reaction with $H_2$, or to reduce iron oxide to pure iron in the iron-making process. The objective of this study was development of active cathode for $CO_2$ electrolysis.

In chapter 1, background of high temperature $CO_2$ electrolysis was introduced and made clear of the objective of this study.

In chapter 2, metallic cathodes were investigated. Ni-based metallic candidates are preferably used as the electrodes. It was found that Ni shows high activity. However, coke formation was observed during the initial period. Furthermore, the electrolysis current could be greatly improved by adding Fe to Ni, resulting in a higher current density of 1.84 $A/cm^2$ at 1.6

V and 1073 K on a Ni–Fe (9:1) cathode. SEM observation suggests that improved cathodic activity can be explained by stabilizing Ni fine particles with the addition of Fe.

In chapter 3, the cermet cathodes were studied since it is known that using mixed conductor electrodes is one way to improve cell performance by increasing the number of available reaction sites. I attempted to improve the $CO_2$ electrolysis performance (activity and stability) of Ni–Fe cathode material by creating a cermet by the addition of an oxide ion conductor. In both cases, the addition of an oxide conducting phase further increases the $CO_2$ electrolysis current at 1073 K compared to the Ni–Fe metallic cathode on its own. Ni–Fe–LSFM cermet shows the highest increase in performance, with a cathodic current density of 2.32 A/cm$^2$ at 1.6 V and 1073 K. Ni-Fe-LSFM is highly interesting as a new cermet cathode for $CO_2$ electrolysis.

In chapter 4, oxide cathodes were examined for $CO_2$ electrolysis. Considering the stability of cathode, oxide phase of cathode is ideal, however, because of low activity as well as low conductivity, no active oxide have been reported on cathode for CO2 electrolysis. Various oxides were examined for $CO_2$ electrolysis at 1073 K. It was found that a mixed conductor $LaFeO_3$–based perovskite oxide doped with Sr and Mn for La and Fe site, respectively, shows high activity for $CO_2$ electrolysis. A cell consisting of BLC64/LSGM/LSFM6482 exhibited the highest $CO_2$ electrolysis activity (e.g. a current density of 0.52 A/cm$^2$ at 1.6 V and 1173 K) of

all oxide cathodes investigated, and can reduce $CO_2$ at a rate of 153 μmol/$cm^2$•min at 1173K and 1.6V.

The concluding remarks and future overview are given in Chapter 5.