

Study on Cathode Material for Intermediate Temperature CO₂ Electrolysis by Using LaGaO₃ Electrolyte

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論文題名 :

Study on Cathode Material for Intermediate Temperature CO₂ Electrolysis by Using LaGaO₃ Electrolyte

(LaGaO₃ 系固体電解質を用いる CO₂ の中温電解のためのカソード触媒に関する研究)

区 分 : 甲

論 文 内 容 の 要 旨

Solid oxide electrolysis cells (SOECs), as a method for the conversion of carbon dioxide (CO₂) to more reduced chemical species, is attracting much attention as its high efficiency in electrolysis field and feasibility for direct conversion of carbon dioxide to carbon monoxide ($\text{CO}_2 \rightarrow \text{CO} + 1/2\text{O}_2$). The purpose of this thesis is to explore suitable cathode material with higher activity and stability on LSGM electrolyzer for direct CO₂ electrolysis at intermediate temperatures (973 - 1173 K). Since the critical reactions for CO₂ electrolysis occur at cathode side, various candidates (metallic, cermet and oxide materials) were examined and studied as cathodes for CO₂ electrolysis. It was firstly found that addition of Fe to Ni as metallic cathode material is effective for improving initial cathodic performance on LSGM electrolyte for CO₂ electrolysis. The electrolysis current could be greatly improved by adding Fe to Ni. Diffusion resistance can be decreased and initial coke deposition can be prevented by adding Fe to Ni. The improved cathodic activity can be explained by stabilizing Ni fine particles with the addition of Fe. Then Ni-Fe mixed with an oxide (La_{0.6}Sr_{0.4}Fe_{0.9}Mn_{0.1}O_{3-δ}, LSFM) as a cermet cathode was studied on LSGM electrolyzer for CO₂ electrolysis. A cell using LSGM electrolyte with Ni-Fe-LSFM cermet cathode exhibited much higher activity, a current density of 2.32 A/cm² was achieved at 1.6 V and 1073 K on an electrolyte (LSGM) support cell with 0.3 mm

thickness, which is a remarkable value in the field of CO₂ electrolysis. The last but not least, oxide cathodes were studied for CO₂ electrolysis. A perovskite-structured oxide of La(Sr)Fe(Mn)O_{3-δ} was studied as cathode on LSGM electrolyzer for CO₂ electrolysis. Doping Sr and Mn to LaFeO₃ is highly effective for increasing the cathode activity for CO₂ electro-reduction. La_{0.6}Sr_{0.4}Fe_{0.8}Mn_{0.2}O_{3-δ} could be highly interesting as a new oxide cathode for CO₂ electrolysis in SOECs at intermediate temperatures.