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論文 / 著書情報
Article / Book Information

題目(和文)	全固体型アルカリ燃料電池用アニオン伝導体の物性に基づいた材料設計・性能解析
Title(English)	Systematic design of anion conductors based on their physical properties for solid-state alkaline fuel cells
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Category(English)	Doctoral Thesis
種別(和文)	論文要旨
Type(English)	Summary

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（博士課程）

Doctoral Program

論 文 要 旨

THESIS SUMMARY

専攻： Department of	化学環境学　専攻	申請学位（専攻分野）： Academic Degree Requested	博士 Doctor of　（　工学　）
学籍番号： Student ID Number		指導教員（主）： Academic Advisor(main)	山口　猛央
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要旨（英文 800 語程度）

Thesis Summary（approx.800 English Words ）

Anion exchange membranes with high ionic conductivity, low fuel permeability and durability should be developed to prompt the research and the development of solid-state alkaline fuel cells (SAFCs) which are the potential candidates for power suppliers of vehicle, household and mobile device applications. However, there is no anion conducting materials satisfying simultaneously all these requirements so far, although anion exchange polymers and layered double hydroxides (LDHs) have been briskly studied and developed as the anion conducting materials for SAFC applications, recently. Normally, the ionic conductivity and the fuel permeability are in trade-off, and the alkaline condition in SAFCs attenuates the stability of anion exchange polymers. Moreover, anions confined in the layered structure of LDHs are hardly to move, resulting in low ionic conductivity. Thus, to develop high performing anion exchange membranes, it is important to understand which parameters of each anion conducting materials influence the membrane performance, and how, from the aspect of systematic design of materials. In this study, physical properties of anion conducting materials influencing on the performances of anion exchange membranes are investigated in terms of material system design by synthesizing structure-controlled organic and inorganic anion conducting materials, finally, to suggest design guides for high performing anion exchange membranes for SAFC applications. This dissertation consists of six chapters.

In Chapter 1, the literatures of anion exchange polymers and LDHs were reviewed to figure out the important parameters affecting their performances. In Chapter 2, three kinds of novel pore-filling anion exchange membranes were developed. It was confirmed that swelling of the membranes were effectively suppressed by confining the polyelectrolytes to the nano-sized pores of a rigid porous substrate.

In Chapter 3, the influence of water state and mobility on the ion conductivity and the fuel permeability were analyzed by comparing the cast membranes and the pore-filling anion exchange membranes synthesized in Chapter 2. The pore-filling anion exchange membranes possessed only a small amount of structured water with low mobility because of suppressed swelling of the inside polymer by the framework of porous substrates, while the cast membranes, films of polyelectrolytes, included plenty of free water as well as structured water. Fuel permeation was highly restricted in the pore-filling membranes because of low mobility of structured water, while anion conductivity was kept comparatively high and could be improved more because of the high concentration of anions caused by the suppressed swelling of the membranes. And also it was found that the OH^- conducted dominantly by Grotthuss mechanism in the structured water from the results of higher self-diffusion coefficient of OH^- than other ions as well as surrounded water. The work reported here constitutes the first attempt at investigation of OH^- conduction through the structured water.

In Chapter 4, the influence of water state on the stability of anion exchange groups was investigated using the cast membranes and the pore-filling anion exchange membranes synthesized in Chapter 2. Anion exchange groups in the pore-filling membranes were more stable than those in the cast membranes in spite of being the same polyelectrolyte. This result confirms my idea that lowering attack ability of OH^- caused by low mobility of water improves the stability of anion exchange membranes without changing chemical structure of electrolyte polymers. Fixation of polyelectrolyte in the pores of porous substrates was also important to maintain high stability of the pore-filling membranes, because the escaping polymer from the pores induced the change of water state.

In chapter 5, a series of trimetallic LDHs, $(Mg_{(1-x)}Zn_x)_2Al\text{-}CO_3^{2-}$, with different ratios of Mg^{2+} to Zn^{2+} were synthesized by a coprecipitation method to investigate the physical properties of LDHs affecting ion conductivity. Anion conductivity in a series of LDHs increased, as the interlayer distances and the amount of adsorbed water increased. This implies that the anion conduction occurs mainly in the interlayer spaces, and the adsorbed water encourages the anion conduction in the LDHs.

Finally, a summary of key findings in this work was presented, and the potential applications and the guide for future development of anion exchange membranes for SAFC applications were proposed in Chapter 6.

備考 ： 論文要旨は、和文 2000 字と英文 300 語を 1 部ずつ提出するか、もしくは英文 800 語を 2 部提出してください。

Note : Thesis Summary should be submitted in either a copy of 2000 Japanese Characters and 300 Words (English) or 2 copies of 800 Words (English).