論文 / 著書情報
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Category(English)	Doctoral Thesis
種別(和文)	論文要旨
Type(English)	Summary

（博士課程）
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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 （ 工学 ） Doctor of
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要旨（英文 800 語程度）
Thesis Summary（approx.800 English Words ）

To achieve the large-scale commercialization of polymer electrolyte fuel cells (PEFCs), the development of active, durable and low cost fuel cell electrode is aimed in this dissertation, the design of high performance catalyst materials and catalyst layer structures have been systematically focused aiming to prepare an "ideal" electrode to satisfy most of the requirements for PEFCs. The key discoveries in each chapter of present work are summarized as follows:

In chapter 1, the components and structure of electrode for PEFCs were firstly introduced to give a general view about essential requirements for fuel cell catalyst layers. In addition, a massive literature review of recent developments on novel catalyst materials and design of catalyst layer structures was also introduced by categories to address the importance of systematical consideration of both catalyst materials and catalyst layer structure.

In chapter 2, to achieve high temperature operation of PEFCs, a novel catalyst layer structure consisted of carbon supported catalysts coated with inorganic proton conductors was proposed and this concept was successfully proved by coating zirconium sulfophenylphosphonate (ZrSPP) as a proton conductive layer on carbon nanotube (CNT) supported Pt catalyst via a simple two-step method. ZrSPP-Pt-CNT with homogenously coated proton conductive layers has been successfully prepared and confirmed. In addition, membrane electrode assembly (MEA) consisted of ZrSPP-Pt-CNT was fabricated and its fuel cell performance was investigated and compared with traditional design. According to electrochemical analysis, inorganic proton conductive layer must be carefully designed to avoid the large mass transport resistance.

In chapter 3, the correlation of various carbon supports (platelet carbon nanofiber, tubular carbon nanofiber and carbon black for commercial catalyst) with different structures to start-stop durability of carbon supported catalysts in fuel cell operation condition has been investigated for developing highly durable catalyst materials by examining Raman spectrum and changes of electrochemical active surface area (ECSA) values as well as I-V polarization curves before and after durability test. Carbon supports with higher degree of graphitization showed significant enhancement in the better retention of ECSA value and cell performance due to the less amount of amorphous carbon or defects for carbon corrosion. Consequently, graphitization degree can be applied as effective index to evaluate durability of carbon supported catalysts.

In chapter 4, a novel carbon support with sandwich-like 3D structure by applying exfoliated carbon nanotube (e-CNT) as an effective carbon spacer was successfully prepared to prevent reduced graphite oxide (GO) from restacking. The graphene nanoribbon oxide layers in e-CNT induced homogenous mixing with GO between hydrophilic groups and the residual tubes prevented the restacking of graphene layers when reduction occurred. The 3D carbon composite with enlarged surface area and expanded interlayer distance showed potential as a promising material for energy storage or catalyst support. In addition, PtPd nanoparticles decorated on 3D carbon composite showed homogenously distributed Pt-rich PtPd alloy nanoparticles with an enlarged ECSA value and mass activity toward methanol oxidation reaction, which was superior to GO- or e-CNT-supported PtPd and state-of-the-art commercial catalysts. It is demonstrated that 3D carbon composite has great potential for improving the utilization of precious metal catalysts for PEFCs.

In chapter 5, highly active and durable 3D carbon supported PtCo catalyst has been successfully prepared. PtCo nanocrystals supported on 3D carbon with optimized carbon spacer ratio showed enhanced oxygen reduction reaction activity toward commercial catalyst as result of homogenous distribution of nanoparticles and synergic effects of secondary metal. In addition, 3D carbon supported PtCo also showed high graphitization degree of carbon support with potential of high start-stop durability. Hence PtCo-GO+e-CNT is a promising catalyst with high activity and durability for PEFCs.

In this dissertation, inorganic proton conductors were successfully applied into catalyst layer showing potential for high temperature operation of PEFCs. In addition, graphitization degree was demonstrated as an effective index to evaluate durable carbon support for catalyst. Moreover, novel 3D carbon supports with enlarged surface area and high graphitization degree were successfully developed to prepare active, durable and low cost fuel cell electrode for PEFCs.

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 1 部提出してください。
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