Syntheses and application of phosphates containing nitrogen.

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Abstract

Electric conductivity of phosphate compounds with nitrogen was measured in order to use the materials for cogeneration type of fuel cell system, because the compounds have possibility to use as a new solid electrolyte. We used melamine orthophosphate (MOP), melamine pyrophosphate (MDP) and melamine polyphosphate (MPP) as melamine phosphates, and ammonium polyphosphate forms I (APP I), II (APP II) and V (APP V) as ammonium polyphosphates. The conductivity of the materials was measured by impedance analyzer. The conductivity of MDP with mixture ratio of diammonium hydrogen phosphate : melamine = 1:1 and prepared at 200°C was 6×10^{-4} S/cm and was the highest value at 200°C.

INTRODUCTION

Consumption of fossil fuel causes a lot of environmental pollution including global warming of living area. Environmental problem is growing up more and more seriously. We have to develop a new energy system quickly to improve environmental conditions.¹ The fuel cell has great possibilities. Table 1 shows some types of fuel cell systems. Solid electrolytes which work at a moderately high temperature (200~500°C) are not studied well. This type of electrolytes has possibilities to use in a cogeneration system, application to an electrochemical hydrogen pump and hydrogen sensor. This study aims to develop a fuel cell which works at moderately high temperature. An inorganic proton conductor such as a heat-resistant macromolecule and a metal oxide is effective to operate the fuel cell at 100~300°C. It is expected that a phosphates with high condensation degree with containing nitrogen are effective as materials satisfying this demand. We used a various phosphorus nitrogen compounds in this experiment and measured their conductivity at a moderately high temperature.

Table1. Some types of fuel cell

	Alkaline	Phosphoric acid	Proton exchange membrane	Molten carbanete	Solid oxide
Electrolyte	KOH	Phosphate	high polymer film	Molten carbanete	Yttria Stabilized Zirconia
Operation temperature (°C)	100	200	100	650	1000
fuel	high purity hydrogen	hydrogen	hydrogen	hydrogen	hydrogen
Power generation efficiency	60%	35~45%	40%	45~55%	50%
use	Special environment (space, deep sea)	cogeneration (bus)	car	cogeneration (large scale)	cogeneration (middle scale)

EXPERIMENTAL

The phosphate compounds containing nitrogen of melamine orthophosphate (MOP), melamine pyrophosphate (MDP), melamine polyphosphate (MPP) and ammonium polyphosphates (APP) of forms I, II and V were prepared according to usual process.² Disks of these powder samples with 1mm thickness were prepared. These samples were coated by Au on the surface of both sides. Electric conductivity was measured by impedance meter. Composition of raw materials was examined to improve electric conductivity. A mixture of diammonium orthophosphate and melamine with mixing molar ratio of 1:1 was heated at 220~280°C for 2 hours. A mixture of diammonium orthophosphate and melamine of mixing ratio of 1:1 to 1:0.5 were heated at 200°C for 2 hours.

RESURT AND DISCUSSION

The conductivity of APP forms I, II and V were measured at 100°C, and the conductivity was 9×10^{-5} , 6.7×10^{-8} and 5×10^{-5} S/cm, respectively. APP showed high conductivity, but these compounds were not able to use at 200 °C because the compounds decomposed at the temperature. The conductivities of MOP and MDP were measured at 200°C, and were 2.6×10^{-9}

and 7.9×10^{-5} S/cm, respectively. The conductivity of MPP was measured at 200°C, and it was 6.3×10^{-5} S/cm. MDP showed the highest conductivity. The conductivity of MDP was dependent on reaction temperature and mixing ration of diammonium phosphate and melamine.

Fig1. ^{31}P MAS NMR of melamin pyrophosphate

Fig2. X-ray diagrams of melamin pyrophosphate

Fig3. Electric conductivity of APPs

Fig4. Electric conductivity

REFEREMCES

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