DOI 10.5162/IMCS2018/P1FW.2

# Chitosan-Based Polymer Electrolytes Containing Various-Shaped Metal Nanoparticles and Development of Flexible Electrochemical Gas Sensors

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**Abstract**

With the emergence of wearable devices and internet of things (IoT), it is expected that small, flat, and flexible sensors will be required for these applications. One of the prerequisites for sensor to be applied to such fields is the development of polymer electrolytes with high ionic conductivity. Since most polymer electrolytes have low ionic conductivity, various nanoparticles and organic materials have been used as fillers and plasticizers, respectively, to increase ionic conductivity. Many phenomenological studies have been done, but the mechanism of how the ionic conductivity increases is not well understood. In this study, we investigate the relationship between the ionic conductivity and the material and morphology of nanoparticles, and explore the role of fillers in polymer electrolytes. As a further study, we report on a planar and flexible electrochemical gas sensor fabricated using an optimized polymer electrolyte.

**Key words:** flexible sensor, electrochemical sensor, gas sensor, polymer electrolyte, ionic conductivity

## Introduction

Since its first appearance as a sensor for detecting oxygen in the 1950s, electrochemical sensors have been miniaturized and their performance has been improved to the level where they can detect various kinds of gases.[1] Compared with the past, the size of the sensor was significantly reduced and their performance was considerably improved. However, most sensors available on the market are still inadequate for application to smart systems such as wearable devices, internet of things (IoT), because they are cylindrical and rigid.[2] Therefore, many efforts have been made to develop planar and flexible sensors that can be easily applied to smart system. One of the obstacles to overcome to develop planar and flexible electrochemical sensors is the development of flexible solid electrolytes with high ionic conductivity.

## Results and Discussion

Polymer electrolytes have been received attention as candidate electrolytes for flexible electrochemical sensors because they are not brittle and are flexible. Most polymers used as host materials for polymer electrolytes are polyethylene oxide-based polymers. Because such polymers are not biodegradable, they can be substances that pollute the environment. In addition, because such polymers are made from petroleum, they do not match the current trend of trying to reduce the use of fossil fuels.[3] Therefore, many researchers have attempted to develop polymer electrolytes using eco-friendly materials such as chitosan. However, ionic conductivity of chitosan is too low to use in electrochemical sensors. Until now, many researchers have tried to increase the ionic conductivity by adding various additives such as glycerol as plasticizer, and inorganic nanomaterials as filler.[4] Despite such efforts, the detailed mechanism of how fillers and plasticizers increase their ionic conductivity is not well understood. In this study, we tried to synthesize various types of nanoparticles with various metals, and to investigate the correlation with ionic conductivity. And we will make a planar and

flexible electrochemical gas sensor using optimized polymer electrolyte and report its characteristics.

**Acknowledgements**

This work was supported by the Technology Innovation Program funded by the Ministry of Trade, Industry and Energy (MOTIE, Korea) [Project Name : Development of Micro Electrochemical Gas Sensors and Measuring-Telecommunication Technology using Porous Electrode and High Conductive Electrolyte (10069215)].

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