Abstract Title

Visualizing and Characterizing of Pore Structures of Nafion Membrane Cast in Bioelectrochemical Sensors

Authors' names

Ju Chou[1], Asanga D. Ranasinghe[2], Kelli Philliphs[1], Steven K. Buratto[2], Horia Metiu[2], Eric W. McFarland[3]*

Authors' affiliations

[1]Department of Chemistry and Physics, Southeastern Louisiana University, Hammond, LA 70402, USA
[2]Department of Chemistry and Biochemistry, [3]Department of Chemical Engineering University of California, Santa Barbara, CA 93106, USA

Abstract body

Since the identification of nitric oxide (NO) as a possible endothelium derived relaxing factor, numerous biological activities involving NO have been discovered. The investigation of the role of NO may bring new insights into its effect on biological activities, such as brain damage, alcoholism, and memory loss. The difficulties of analyzing these activities are that NO is highly reactive and is present at low concentration in the living organism.

Electrochemical methods can provide direct measurement for nitric oxide and have several advantages that are not available using analytical spectroscopic methods. We have developed biosensors for detecting NO by using heme protein covered with Nafion film electrodes. The electron transfer rate of heme proteins is enhanced when they cast in the Nafion film and NO can be electrocatalytically reduced at these hemoprotein-Nafion film electrodes. However, there is limited information about the pores and the density of Nafion membrane. We have combined electrochemical methods and microscopic techniques to characterize and visualize the pore structures of Nafion membrane.

The first electrochemical method involves the creation of metal lithographs with Nafion as a template and without Nafion. Without Nafion, using hydrogen terminated n-doped Si(111) we deposited gold continuous film from an electrolyte containing a gold salt. With Nafion membrane, the Au ions traverse the membrane through the pores, reach the silicon surface and are spontaneously reduced. A metallic Au deposit is formed on the silicon surface through pores of Nafion. The Au deposits are visualized after dissolving the membrane by atomic force microscope (AFM) and scanning electron microscope (SEM). Another method involves supporting the membrane on a HOPG (highly oriented pyrolytic graphite) and depositing Pd nanoparticles through the hydrophobic pores of the membrane. The membrane and the deposition of Pd are visualized by AFM and SEM. The Au and Pd depositions through Nafion membrane provide a positive image of the size and the shape of pore structures (channels) of Nafion membrane.

Several series of AFM and SEM images will be presented which display the deposition of metal nanoparticles using Nafion as a template on either n-doped Si(111) surface or HOPG

surface because their surfaces are atomic flat. We will present the images of metal deposition with Nafion, without Nafion, and after removing Nafion. We will also display the determination of the surface composition to monitor Nafion film by energy-dispersive spectroscopy (EDS). The metal deposits provide a footprint of the Nafion pores that cross the membrane, and their density and their size (ranging from several nanometers to 100 nm).

The thickness of Nafion film formed on the electrode surface will be measured by scanning electron microscope.

Keywords

Nafion membrane, Pore structures, electrochemical deposition, Nanoparticles, electrochemical sensor, atomic force microscopy, scanning electron microscope

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Corresponding author contact information

Ju Chou: Department of Chemistry and Physics, Southeastern Louisiana University, Hammond, LA 70402, USA
Phone: 895-549-3480; Email: Ju.Chou@selu.edu