전도성 복합재료 필름을 응용한 Electromechanical actuators

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Electromechanical actuators using conducting polymer composite films

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1. Introduction

Conducting polymers show several unique features, wherein electrical and optical properties change drastically during electrochemical reaction. By making use of these phenomena, several electronic devices have been fabricated, for instance, electrochromic displays, rechargeable batteries and electroplasticity memory devices.

Electromechanical actuators using conducting polymers have been proposed by Baughman et. al [1]. Pei et. al [2] and Otero et. al [3] demonstrated actuators utilizing deformations of polypyrrole films upon electrochemical doping. Osada et. al were also studied about a polymer gel actuator [4].

The emeraldine salt (ES) is electrochemically oxidized or reduced in aqueous acid, resulting in pernigraniline (PS) and leuco-emeraldine (LS) salts, respectively. The electrochemical oxidation of polyaniline occurs with removal of both protons and electrons from nitrogens. The chemical structure of benzene ring changes from phenyl to quinonoid structure upon oxidation and vice versa for reduction. These structural change result in deformation of polyaniline film. Remarkably, in the case of polypyrrole, this deformation attributed to the incorporation fo ion [3].

In this paper, conducting nylon 6-based composite films have been prepared by oxidation polymerization. We described the characterization of film containing the fabrication of electrochemical actuators.

2. Experimental

2.1 Material and Reagent

Nylon 6 film [Hyosung co.] of thickness 15~20 ㎛ was used as polymeric matrix. Aniline was distilled under vacuum before use. All reagents used in this work were special grade and used without further purification.

2.2 Preparation of composite film

Before testing, nylon 6 films were washed with deionized water, then cleaned with methanol. The resulting product was dried under reduced pressure. The composite films were prepared employing the published method [5] with some modifications. The nylon 6 films were first soaked in aniline monomer for 1~2 h. Then the film was blotted dry with filter paper to remove the residual monomer on the film surface. The aniline-containing film was dipped into a 1 M HCl solution containing $(NH_4)_2S_2O_8$. The polymerization time and temperature were in range of 5 min~4 h and 5~30 ℃, respectively. This composite film was washed with distilled water to remove the residual $(NH_4)_2S_2O_8$ on the film surface and dired in vacuum at room temperature for 24 h.

2.3 Film characterization

The conductivity of the composite film was measured by using the four-probe method. The morphology of the composite film was investigated with a JEOL JSM-633OF field emission scanning electron microscope.

The ultra-violet(UV)- visible absorption spectroscopy analysis of films was made using SCINCO UV s-2100 and prinstine nylon 6 film was used as a reference.

The Cyclic voltammetry(CV) was measured by DC CRROSION & IMPEDANCE SYSTEM (EG&G). Pt sheets were used as the counter (CE) and reference (RE) electrodes, respectively.

2.4 Construction of the actuators

A piece of PANI-N composite film (5mm × 30mm × 20㎛) was prepared. Two platinum foils were placed at two side of film, respectively. These were affixed by glass plate. This can be operated in free space.

3. Result & discussion

Figure 1 shows the effects of the oxidant concentration on the conductivity of the PANI-N composite film. As shown in Figure 1, the conductivity of the PANI-N composite film increases with increasing the $(NH_4)_2S_2O_8$ and estimates as a maximum value at 0.25M of $(NH_4)_2S_2O_8$, then tends to decrease. this result is similar to other paper [5].

Figure 2 shows a CV curve in PANI film during an electrochemical cycle in HCl aqueous solution. The states of emeraldine (ES) and leuco-emeraldine (LES) salts are shown. The degree of oxidation is about 5%.

Figure 3 shows photograph of actuator formed PANI-N composite film.

The all-plastic actuators were fabricated using Polyaniline-Nylon 6 composite film. It was found that the emeraldine salt layer expands by the oxidation and contracts upon reduction. The electrochemical actuator using PANI-N composite film can be constructed in the simplest and most efficient ways.

4. Reference

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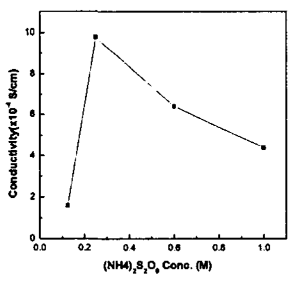

Figure 1. Variation in the conductivity with for PANI-N comsite film.

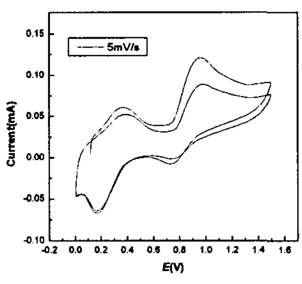

Figure 2. Cyclic voltammogram of PANI-N composite film during an electrochemical cycle at the scan rate 5mV/s.

Figure 3. Photograph of electromechanical actuator