The Research Reports of the Faculty of Engineering, Kagoshima University, No.53 (2011)

Doctoral Dissertation, Graduate School of Science and Engineering, Kagoshima University, Doctorate No.343

Development of Surface Plasmon Resonance Sensor with Separation Ability Using Diffusion in Membrane towards Small Analyzers for General Use

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1. Introduction

Surface plasmon resonance sensor is based on the interaction between the incident light and the surface plasmon at the metal film interface. Its configuration is simple as such extensive works on the development of small and compact sensors for field and medical application are being done. It responds to the total refractive index of a sample, thus it cannot be applied for component determination in mixture samples. This study aims to be able to determine the concentration of the components in a mixture sample using the SPR sensor for general use. Attaching an agar as membrane to the Au film in the SPR sensor system enables component separation through the diffusion principle. Using Fick's law and linear analysis, the concentrations of each component in several mixture samples are computed.

2. Results and Discussions

An SPR sensor using Au as the metal film attached with a membrane was constructed. An agar and water-soluble compounds were chosen as model compounds for development of the system. The agar was convenient as a membrane because it has a refractive index lower than the prism used and this condition is required for evanescent waves to occur. The agar membrane with about 670 μm in thickness was prepared by spreading evenly 20.0 μl of 4% agar-aqueous solution on the Au film.

Qualitative analysis using this SPR-agar system is due to the differences of the diffusion coefficients of solutes analyzed. Diffusion coefficient of solute in solution is generally represented using the Stokes-Einstein equation, in which the molecular radius determines the diffusion coefficient. It is important to study the factors that would affect diffusion coefficient in an agar membrane in order to establish possible analytical applications of this system. Basic researches on the diffusion phenomena in the agar membrane were done by measuring the rise times of the SPR signals. Rise time is the time midway between the initial and saturation points. This is indirectly proportional to the diffusion coefficient. This SPR system was found to be dependent on the size of the molecules but not in concentration, room temperature and the number of –OH groups of the chemical compound corresponding to chemical interaction.

Different mixtures composed of various chemicals with various ratios were used as model mixtures. Curve-fitting techniques, followed by the transformation of the SPR time chart to the single exponential function, were developed for the data analysis of mixtures. The measured concentrations of the components agreed well with the expected ones of the components in the mixture. The separation ability of this system for mixtures is a factor of 3 in terms of difference in molecular weight based on the results obtained using methanol and 2-methyl-2-butanol mixtures. Thus, based on the results using an agar membrane and some chemicals as models, the SPR-membrane system developed was able to separate and detect the components in the mixture.

3. Conclusions

The SPR sensor using Au metal film attached with a membrane was developed. The curve fitting technique was also developed to determine the concentrations of the components in the mixture. Good agreements were obtained between the expected and measured concentrations. This system developed is a useful basis for further development of compact SPR sensors with separation ability for environmental on-site and medical sample analysis.

Date of Conferment of the Degree: March 25, 2011