CHAPTER 4

CONCLUSION

Spherical soap bubbles and planar soap films were developed and investigated for determination of gases or vapors in flow systems. A spherical soap bubble was used as a gas sampling interface for in situ determination of SO_2, and for investigation of conductometric characteristics of a hollow spherical film.

The planar soap film was employed as a thin liquid membrane for chiral vapor permeation study. The results of these studies are summarized as follows.

Development of spherical soap bubble in flow system for gas sampling interface

A system was successfully developed to automatically generate renewable and reproducible spherical soap bubbles. Bubble size was 41.7 ± 0.8 mm in diameter with 1.9 % rsd (n=74) with a film thickness of 1.6 ± 0.2 µm for a bubble age of at 5 min. The bubble life time can be prolonged to more than 10 min by placing it in a humidified chamber. The bubble is then ready to be utilized as a gas sampling interface in a flow system.

Conductimetric study of a soap bubble modeled as a hollow sphere

The conductance of a well defined soap bubble was measured by adding H_2SO_4 in soap solution. The electrodes were placed at opposite polar locations of the bubble and the interelectrode distance could be adjusted to fit the bubble size. A decrease of conductance with the age of the bubble was observed, possibly due to thinning of the bubble wall by the flow of solution to the bottom by gravity. Conductance values obtained from the experiments agreed well with those from a presently developed theoretical model. The conductance on soap film is governed by equation:

$$G = \frac{\pi\delta\sigma}{\ln\left(\cot\frac{r_e}{2r_b}\right)}$$

where r_e, r_b, σ and δ are respectively the electrode radius, bubble radius, solution specific conductance and the film thickness, respectively.

Spherical soap bubble for continuous SO_2 gas sampling and analysis

A well defined soap bubble generated from a solution containing H_2O_2 and a non-ionic surfactant (Triton X-100) was used for SO_2 gas sampling and analysis. Conductance change in the soap film due to H_2SO_4 produced from reaction of SO_2 and H_2O_2 was measured. The calibration graph from various SO_2 concentrations (0-947 ppbv) showed linear relationship with r^2 of 0.9778 and limit of detection of 37 ppbv (based on three times the standard deviation of the blank) was achieved. The reproducibility was 3.9% in relative standard deviation (n = 5) in a SO_2 concentration range of 200-1000 ppbv.

Planar soap film in a flow system for investigation on permeation of chiral compound vapors

A film of TX-100 surfactant, formed manually in a planar configuration on a plastic frame was studied to investigate the permeation of different α-pinene isomers. A film formed from 5 % TX-100 in 10% glycerol and placed horizontally was found to be suitable for study of vapor permeation. TX-100 content, which controls the number of micelles in the film, affected the transfer rate of α- pinene across soap film. Glycerol which was added to increase stability of the soap film also increased the viscosity and decreased the rate of α- pinene mass transfer. These results support the idea that α- pinene may transfer across a TX-100 soap film by dissolving in the non-polar micelle on the donor side and evaporate on the receiver side. With addition of α-cyclodextrin in soap solution, the transport rates of the two different chiral forms of α-pinene became different and resulted in enrichment of one form over the other in the permeate stream. The separation factor defined as the ratio of the concentration of (+) α- pinene to that of (-)α- pinene on the receiver side, increased with increasing of α-cyclodextrin content in the soap film. A separation factor of 1.45 was obtained by using 10% α-cyclodextrin. Soap films in conjunction with chiral selectors are promising tools for enantiomeric separation.

Suggestions for Further Investigation

Some further investigations are suggested as listed below:

1. The sequential injection system for soap bubble gas sampling and analysis should be further investigated for application to real samples.

2. The physical structure of a soap bubble is that of a liquid film of high refractive index (RI) sandwiched by low RI air/gas. It should act as a light guide similar to optical fibers. The optical transmission characteristics along the film of a large-diameter soap bubble should be further studied to be used as a long path length optical cell.

3. In planar soap films for vapor permeation studies, the effect of the soap film thickness and viscosity of soap solution need to be investigated.