Research Activity Report **2013.10.31**

Research title		Fabrication of selective membrane for permeation varied with environment and establishment of the technique for active mass transfer control of protein
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Visiting institution		INSA Lyon, France
Visiting period		November 2011 - November 2012
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	Title	Professor

Summary of Collaborative Research Activities

Recently, biological engineering requires several key properties with regard to diffusion phenomena of proteins in order to study the mass transfer system in human body. However, intravital condition cannot be assumed to free diffusion because there are several kinds of chemical components in the system. This means a hindered diffusion should be taken into account in human body. In this collaborative activity, the transient concentration field of protein due to mass diffusion in the vicinity of the thin membrane was quantitatively visualized by phase shifting interferometer. The visualization experiments were conducted under isothermal condition by using typical protein, Lysozyme from egg white. From the visualization results, the mass flux was determined and compared one another. The mass flux was decreased in the order of one magnitude compared to that of free diffusion.

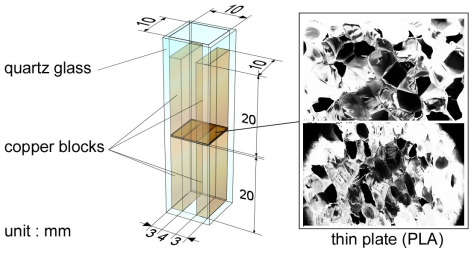


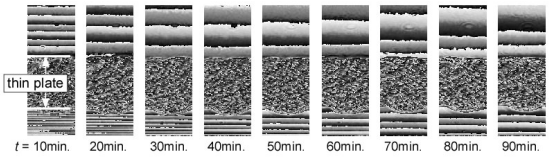
Fig.1: Schematic of diffusion cell and photos of thin membrane, PLA.

For the formation of small diffusion field, a quartz glass cell was developed in this study. The cell is comprised of quartz glass, four copper blocks and a thin membrane as illustrated in Fig.1. As a thin membrane, Poly lactic acid (PLA) also shown in Fig.1 was used.

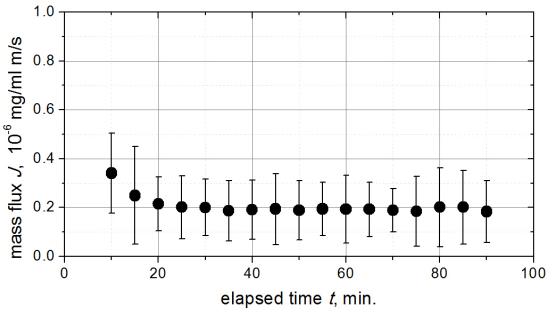
Figure 2(a) shows a typical visualization result of transient diffusion field of protein. As is obvious in Fig.2(a), transient diffusion field could clearly be visualized by the interferometer. In the hindered diffusion at the region of low concentration field (upper region), the diffusion progressed during first 10 min., however, the fringe number suddenly decreased between 20 min. and 60 min. This is caused by the lack of supplying molecules from the thin membrane. After 60 min., the fringe number increased again because enough supply of protein molecule from thin membrane was started. Figure 2(b) shows the variety of mass flux in the vicinity of membrane surface with elapsed

time in upper region. As is obvious from Fig.2(b), the mass flux finally reaches a certain value as time elapsed. However, it dynamically varies in early stage of diffusion time. This result indicates that the Lysozyme molecules are constantly supplied to bulk region after the membrane was filled with lower solution. At a view point of time variation of mass flux, the flux increases approximately double in this case. This gain regarding to time also has a potential to actively control the protein transport.

From the experimental data, it is shown that the thickness of the thin plate is one of appropriate parameter for control of protein transport. Furthermore, time variation of mass flux in the vicinity of the thin plate was discussed.



(a) typical results of visualized diffusion field



(b) time variety of mas flux

Fig. 2 : Experimental results

Publications

1) Journal or conference papers with full paper review

[1] Atsuki Komiya, Jérôme Chevalier, Sébastien Provost and Sébastien Livi, Visualization of protein diffusion field in the vicinity of surface of thin plate, *The 8th World Congress on Experimental Heat Transfer, Fluid Mechanics and Thermodynamics*, (2013), USB-447

[2] Atsuki Komiya and Jérôme Chevalier, Experimental Trial to Active Control of Protein Mass Flux in Hindered Diffusion Field, *The 23rd International Symposium on Transport Phenomena*, (2012), USB-268.

[3] Atsuki Komiya, Jérôme Chevalier, Sébastien Provost and Sébastien Livi, Quantitative evaluation of mass flux of protein through the poly lactic acid (PLA) thin plate, *J. Control. Release*, to be submitted.

2) Conference papers or presentation without full paper review

[4] Atsuki Komiya, Jérôme Chevalier, Sébastien Provost and Sébastien Livi, Evaluation of Protein Mass Flux in Hindered Diffusion Field, *2013 Annual ELyT Workshop*, (2013), 62-63.

[5] Atsuki Komiya, Sébastien Provost, Sébastien Livi and Jérôme Chevalier, Active Mass Transfer Control in Diffusion Field by Smart Materials, *2012 Annual ELyT Workshop*, (2012), 60-61.

3) Patent, award, press release etc.

Not applicable