水・ミセル間分子輸送の理解と微量生化学分析への応用

（東北大多元研[1]）○福山 真央[1]
Understanding of Molecular Transfer between Aqueous Phase and Micelles and Its Application to Microbioassays (*[1]Institute of Multidisciplinary Research for Advanced Materials, Tohoku University*) ○Mao Fukuyama[1]

  Micrometer-sized water-in-oil droplets (microdroplets) has been utilized as a chemical container for trace bioassays since they can compartmentalize small amount of reagents and samples. Conventionally, microdroplets were only used for compartmentalization, and chemical pretreatments, such as preconcentration and purification, for microdroplets' contents were limited. Recently, we found that spontaneous emulsification (SE) occurred at the microdroplets' surface when the microdroplets were immersed in an organic phase containing Span 80, a non-ionic surfactant, and reagents in the microdroplets were selectively enriched during SE. We established the selective enrichment as a pretreatment for trace analysis in microdroplets based on understanding molecular transport between microdroplets and Span 80 reverse micelles during SE. To indicate the applicability of this method to biochemical analyses, the control of the protein crystal nucleation and immunoassay was demonstrated in the microdroplets. This selective enrichment method is expected to enable quantitative analysis of micro- and submicrometer-sized biochemical phenomena.
Keywords ： Microanalysis, Interface chemistry, Surfactant

　マイクロメートルサイズの油中水滴（マイクロ水滴）は微量の試薬や試料の閉じ込めが可能であり、微量分析の反応場として利用されてきた。しかし従来マイクロ水滴は「サンプルや試薬を閉じ込める微小空間」として使われるのみであり、濃縮・精製などの化学的な分析前処理操作が確立されていなかった。我々はマイクロ水滴をSpan 80（非イオン性界面活性剤）を含む有機相に接触させると自然乳化が起こり、マイクロ水滴内の溶質が選択的に濃縮されること発見した。自然乳化中のマイクロ水滴・Span 80 逆ミセル間の水・溶質分子輸送を理解することで、自然乳化を用いた選択的濃縮をマイクロ水滴内微量分析の前処理操作として確立した。本選択的濃縮法を利用し、生化学分析への応用可能性を示すため、マイクロ水滴内でのタンパク結晶核形成制御や、マイクロ水滴内イムノアッセイを実証した。今後、本手法を微量・微小の生化学現象の定量分析に展開していきたい。

1)　M. Fukuyama and A. Hibara, *Anal. Chem.*, **2015**, 87, 7, 3562-3565.
2)　M. Fukuyama, A. Hibara, Y. Yoshida, K. Maeda. *Anal. Chem.* **2017**, 89, 17, 9279.
3)　M. Fukuyama, M. Tokeshi, M.A. Proskurnin, A. Hibara
　　Lab Chip, **2018**, 18, 356.
4)　M. Fukuyama, L. Zhou, T. Okada, K. V. Simonova, M. Proskurnin, A. Hibara
　　Anal. Chim. Acta, **2021**, 1149, pp. 338212 – 338212.