油中水滴・逆ミセル間の輸送現象と選択的濃縮法・バイオ分析法

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Transport phenomena between water-in-oil droplets and reverse micelles and their applications to selective enrichment and bioanalysis (*Institute of Multidisciplinary Research for Advanced Materials, Tohoku University*) ○Akihide Hibara, Mao Fukuyama

Micrometer-sized aqueous droplets dispersed in organic phase have been often utilized for chemical and bioanalysis. Generally, the droplet surrounded by the organic phase can be regarded as an isolated filed, to encapsulate molecules, particles, biological cells, etc. Although the encapsulation is advantageous for various analytical applications, such as single cell analysis, versatile and flexible chemical operations such as separation and enrichment will enlarge the possibility of droplet microfluidics very much. Then, we conceived the aqueous microdroplet selective enrichment method [1,2]. By utilizing the method, we demonstrated protein assay [2] and crystallization [3]. We revealed that the selective enrichment could be explained by dynamic partition of water or solute from the aqueous microdroplet to hydrophilic space of reverse micelles. To demonstrate the dynamic feature of the method's principle, we demonstrated solute enrichment control only by the flow rate [4-6]. This method is versatile and flexible, and then is expected to be applied to various analytical applications.
Keywords : Microfluidics; Microdroplet; Reverse Micelle; Selective Enrichment

マイクロメートルサイズの油中水滴は化学・バイオ分析に頻繁に用いられている。多くの場合、マイクロ水滴は、分子・粒子・細胞などを閉じ込めて孤立場として利用される。この孤立場は単一細胞分析のような先端分析に有効である。この手法に簡単かつ柔軟に利用できる分離精製法が組み合わされば、マイクロ水滴の用途が大きく広がると期待できる。そこで、われわれのグループでは「マイクロ水滴に適用できる選択的濃縮法」を着想した[1,2]。この方法を用い、タンパクアッセイ[2]やタンパク結晶化[3]を実証した。この分離・濃縮の原理を詳しく検討した結果、マイクロ水滴から油相中逆ミセルへの水の輸送現象が、ミセルの水和度合いに基づく動的過程であることを見いだした。また、溶質の輸送現象は、水輸送の結果としての水和度合いにも依存することが分かった。溶質の種類に依存した輸送速度は単純な親水性／疎水性の描像だけでは説明困難な現象も見いだされている[4-6]。今後さらに現象解明を進めた上で、その原理に基づく一細胞イムノアッセイなどへ手法の応用を広げていく予定である。

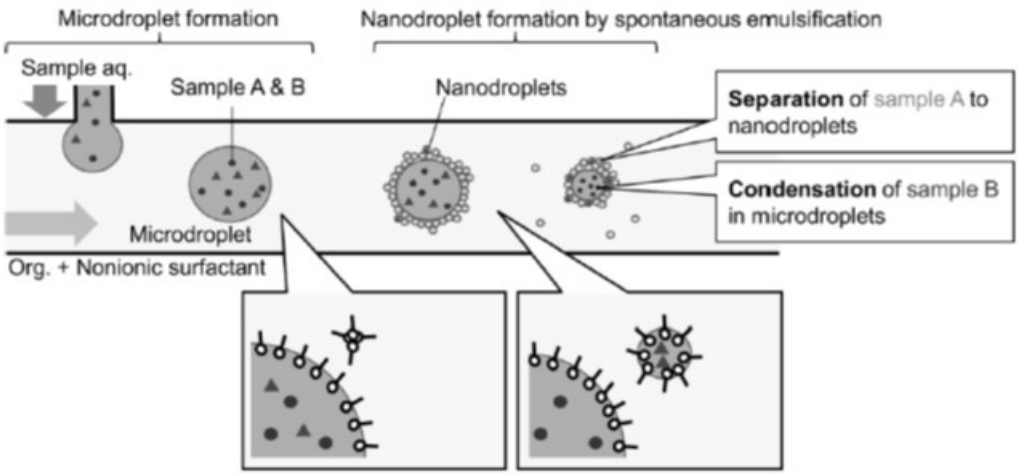

Fig. 1 Conception of microdroplet selective enrichment. Reprinted with permission from Ref. [1]. Copyright (2015) American Chemical Society.

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