Emulsification with Microstructured Devices

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Introduction

Emulsions are widely used in several products including food, cosmetics, pharmaceuticals and petrochemicals. Typically the droplet sizes are from 0.1-100 μm, and the droplet size and size distribution are the most important parameters that determine the stability and rheological properties of emulsions.

For the preparation of monodisperse emulsions, membranes and microstructured devices such as microfluidic chips becoming more and more popular since they allow better control over the emulsification process. See Figure 1 for examples of microfluidic devices and products.

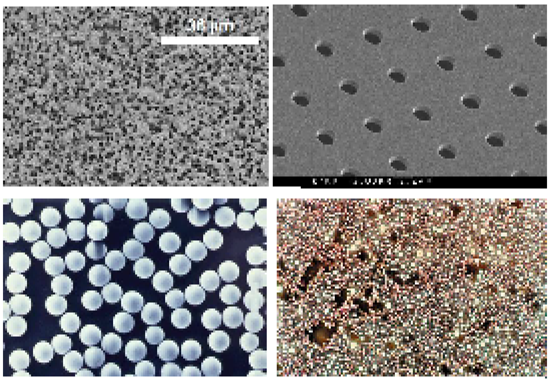

Fig 1: Top left, Shirazu porous glass membrane. Top right, microsieve. Bottom left polymeric particles used as spacers in LCD screens. Bottom right, low fat spread (Morinaga).

Traditional emulsification devices, which use high shear and extensional stresses, have poor control over droplet size and produced emulsions are quite polydisperse. Furthermore, most of the energy put into the product is dissipated as heat which may lead to damage of heat and shear sensitive ingredients. The small size in microstructured devices facilitates the monodispersed droplet formation at the scale whish is most relevant for both science and industry.

Research

In our lab we developed the so-called EDGE-system, which is a microstructured slit (plateau) located between a dispersed phase channel and a continuous phase channel. Droplet formation takes place along the edge of this plateau at several positions, driven by Laplace pressure differences; see Figure 2 for droplet formation in a typical EDGE design.

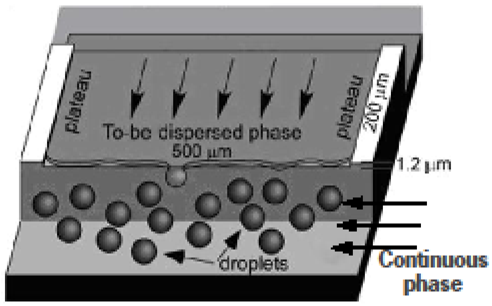

Fig 2: Schematic representation of droplet formation in a typical EDGE unit.

In EDGE emulsification, a scaling factor of 6 was found between the droplet size and plateau height ($D_{drop}/H_{plateau}$). The system was found to be very stable, not sensitive to small pressure deviations in a broad pressure range and to fouling.

Targets

In this project we mainly focus on producing W/O/W emulsions which are especially shear sensitive, and of particular interest for encapsulation and also light products.

The goals of this project are to produce double emulsions where both the inner and outer phases are controlled through EDGE technology, and to further scale up the EDGE systems.

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