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Disposable ultrasonic emulsification microchannel chip fabricated by nanoimprint lithography

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Background, Motivation and Objective

Emulsification technology is widely used in various fields such as foods, cosmetics, and pharmaceuticals. At present, new emulsification method using metal microchannel is investigated for the purpose of maintaining the sterility and eliminating the undesired noise. However, the machining cost of metal microchannel is very high, and cleaning is required for reuse and therefor there are hygiene issues. In order to resolve these issues, we developed a disposable ultrasonic small emulsification device.

Statement of Contribution/Methods

This device has the structure in which a microchannel chip and a piezoelectric element are combined (Fig. 1(b)). Polydimethylsiloxane (PDMS) is used as the material of the microchannel chip (Fig. 1(a)). PDMS allows the fabrication of fine structures by nanoimprint lithography, therefore the duplication of identical chip is easy and the mass production costs less. PDMS, which is a silicone and environmentally friendly material, is suitable for the disposable chip. The solution flowing through the PDMS microchannel chip is emulsified by the third overtone wave of the fundamental resonance frequency (294 kHz) irradiated by the piezoelectric element.

Results/Discussion

In this study, we used the oleic acid mixed with lecithin, which is an oil phase, as the continuous phase and the pure water, which is an aqueous phase, as the disperse phase. The flow rate between the oil phase and the disperse phase was 5:1 or more, respectively. Figure 2 shows the diameter of the emulsification droplets produced with the stirring rod and the developed device. Emulsification with the stirring rod contained the droplets with large diameters of 50 µm or more, however using the developed device, the fine droplets of about 20 µm or less were stably obtained. This result indicates that the developed device will open up a new door of emulsification technology.

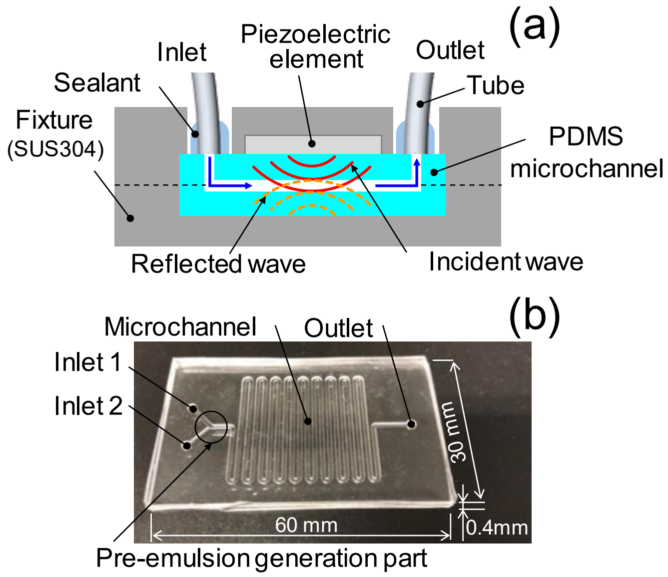

Fig. 1 Ultrasonic emulsification microchannel device: (a) Schematic of emulsification apparatus, (b) PDMS microchannel chip fabricated by imprint lithography.

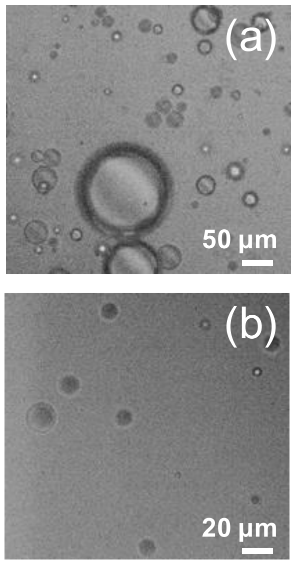

Fig. 2 Comparison of the emulsification droplets diameter: (a) Stirring rod, (b) ultrasonic emulsification microchannel chip.