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Automated, multichannel femtoliter bead-in-droplet formation for beaming (Beads, Emulsion, Amplification, Magnetics) technology

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In this work, we developed an automated multichannel system which forms uniform femtoliter bead-in-droplet for BEAMing (Beads, Emulsion, Amplification, Magnetics) laboratory test. BEAMing has been proposed for detection of minute quantities of circulating tumor DNA (ctDNA) in the blood. It is one of the digital polymerase chain reaction (dPCR) techniques1, 2 the droplet size was controlled for formation of ten droplets for each single DNA molecule and a primer-coated magnetic bead. Beads emulsification by manual method or commercial automated liquid handling robots is efficient, but difficult to regulate the number of beads in droplets. Our system, shown in Fig. 1(a), attained the stable flow in each junction, forming single bead-encapsulated droplets without any failure in all channels. Our microfluidics cartridge has the junction with dimensions 20 × 20 µm (Fig. 1(b)). The droplet diameter and volume is approximately 8 µm, 268 fL, and the CV of diameter is less than 6 % with aqueous-phase flow at 0.4 µL/min and oil-phase flow at 2.1 µL/min (Fig. 2). We conducted BEAMing assay with this system using DNA sample including 1.0 % mutant DNA. As shown in the Fig. 3, mutation detection was succeeded in all channels, and the distribution of detected mutation rate was CV = 7.0 %. The result of this study shows that multichannel bead-in-droplet formation using microfluidics achieves more reliable and efficient beaming, leading the technological evolution of digital PCR.

Biography

Hiroyasu Takei has completed his PhD from Osaka University, and conducted research on precision machining using atmospheric pressure plasma with nanometer accuracy. He obtained significant experience in micro/nano fabrication and system development. Currently, he is working on the genome diagnostics platform development using microfluidics by making use of his experience of equipment design and machine control electronics.

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