Centrifugal microfluidic device for Raman Imaging and beating motion analysis study of single Cardiomyocytes

TAMIYA, Eiichi (Graduate School of Engineering, Osaka University)

This study presents the design and operation of a centrifugal microfluidic chip in aiding easy location and observation of single cardiomyocytes for beat motion analysis and Raman imaging. Centrifugal microfluidics was utilized to trap neonatal cardiomyocyte at desired sites without the need for external interconnects to induce fluid flow and the particles can be manipulated even in the absence of flow. This avoids the use of pumps that usually increases the ratio of culture media amount to cell culture population in a conventional microfluidic chip. Approximately, 6500 cells can be trapped in the device. Similar to the previous report, 70-80% of the cells grew and 30% exhibited beating after one day of incubation. With the aim of elucidating beat motion, shape morphology, and cell dynamics relationship, cytochrome c mapping was employed. By mapping the cytochrome c, the arrangement of the mitochondria, and subsequently the sarcomere that is responsible to the contraction motion of the cells, can be determined. Raman spectra were started to be obtained after 3 days of incubation; beating has started to stabilize and cells have distinct elongated morphology. Raman images of the cells were acquired using a 532 nm laser operated with acquisition time of 20s/line. Beat profiles were generated by image correlation analysis of the recorded beat motion of the cells. It was observed that cardiomyocytes with different structures have different distribution of cytochrome c that is highly related to contraction-relaxation heterogeneity.