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Integrated microstructures on chip for ultrasensitive pathogen detection

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Abstract

Nucleic acid amplification based polymerase chain reaction (PCR) technique is popular and gold standard method in molecular biology to amplify a single copy or a few copies of target DNA. It is widely used in molecular diagnostics to detect the wide range of pathogens. To address the huge demand of the molecular diagnostics the development of new integrated rapid and sensitive method for point of care devices is needed. Earlier pathogens detection based on nucleic acid amplification techniques have been more and more attractive and successful. Since it is easy to transfer nucleic acid amplification from liquid to solid phase into lab-on-chip (LOC) devices. Concerning the issues of molecular diagnostics, a solid phase PCR (SP-PCR) technique has been developed and become popular for molecular diagnostics[1–4]. Recently, we have successfully developed a LOC platform based on a combination of SP-PCR with supercritical angle fluorescence (SAF) microlens array embedded in a microchip for rapid foodborne pathogen detection[5]. By integrating the SAF microstructure array into a polymeric chip, the sensitivity of the test was increased to 46 folds compared to a conventional array without SAF[6]. Hence, the SAF microstructures array embedded microfluidic chip is a good strategy to develop a portable device for onside, online, and rapid pathogen detection. However, to enhance the sensitivity of detection and multiplexing of samples, it is required to increase the number of SAF microstructures arrays on a chip. In this report, we addressed this challenge by fabricating small size of SAF microlens array in the microfluidic chamber of a disposable polymer (Cyclic olefin copolymers) chip. The limitation of detection obtained from SAF microstructures array will determine the sensitivity of the developed system. The advantages of increasing the number of sample site by increasing number of SAF and advantages of reducing the size of SAF will be discussed.

[1] J. Hoffmann, M. Trotter, F. von Stetten, R. Zengerle, G. Roth, Solid-phase PCR in a picowell array for immobilizing and arraying 100 000 PCR products to a microscope slide, Lab Chip. 12 (2012) 3049. doi:10.1039/c2lc40534b.

[2] Y. Sun, R. Dhumpa, D.D. Bang, J. Høgberg, K. Handberg, A. Wolff, A lab-on-a-chip device for rapid identification of avian influenza viral RNA by solid-phase PCR, Lab Chip. 11 (2011) 1457. doi:10.1039/c0lc00528b.

[3] Y. Sun, R. Dhumpa, D.D. Bang, K. Handberg, A. Wolff, DNA microarray-based solid-phase RT-PCR for rapid detection and identification of influenza virus type A and subtypes H5 and H7, Diagn. Microbiol. Infect. Dis. 69 (2011) 432–439. doi:10.1016/j.diagmicrobio.2010.11.008.

[4] W.H. Chin, Y. Sun, J. Høgberg, T.Q. Hung, A. Wolff, Solid-phase PCR for rapid multiplex detection of Salmonella spp . at the subspecies level , with amplification efficiency comparable to conventional PCR, (2017). doi:10.1007/s00216-017-0216-y.

[5] T. Quang, W. Hoe, Y. Sun, A. Wol, D. Duong, A novel lab-on-chip platform with integrated solid phase PCR and Supercritical Angle Fluorescence (SAF) microlens array for highly sensitive and multiplexed pathogen detection, Biosens. Bioelectron. 90 (2017) 217–223. doi:10.1016/j.bios.2016.11.028.

[6] T.Q. Hung, Y. Sun, C.E. Poulsen, T. Linh-Quyen, W.H. Chin, D.D. Bang, A. Wolff, Miniaturization of a micro-optics array for highly sensitive and parallel detection on an injection moulded lab-on-a-chip, Lab Chip. 15 (2015) 2445–2451. doi:10.1039/C5LC00176E.