Electronic Supplementary Material (ESI) for Analyst.

Electronic Supplementary Information (ESI)

Fabrication of 3D continuous-flow reverse-transcription polymerase chain reaction microdevice integrated with on-chip fluorescence detection for semi-quantitative assessment of gene expression

Quang Nghia Pham,[a] Kieu The Loan Trinh,[a] Nguyen Khoi Song Tran,[b] Tae-Sik Park [b] and Nae Yoon Lee*[a]

[a] Department of BioNano Technology, Gachon University 1342 Seongnam-daero, Sujeong-gu, Seongnam-si, Gyeonggi-do, 13120, Korea.

[b] Department of Life Science, Gachon University 1342 Seongnam-daero, Sujeong-gu, Seongnam-si, Gyeonggi-do, 13120, Korea.

*Corresponding author.

Tel: +82 31 750 8556

Fax: +82 31 750 8774

Email: nylee@gachon.ac.kr

Table S1. Comparison of chamber-type and CF RT-PCR microdevices

References	Chip design	Integration	Accessories
This study	Continuous-flow	- Amplification - Detection	- A plastic syringe - A hotplate - A fluorescence microscopy
Obeid et al. (2003)	Continuous-flow	Amplification	- Two syringe pumps - Four copper heat blocks
Hartung et al. (2009)	Continuous-flow	Amplification	- Two syringe pumps - Two copper cylindrical heaters
Felbel et al. (2008)	Continuous-flow	Amplification	- A four-channel syringe pump - A heating plate with thin film heaters, temperature sensors, and an electronic controller
Tsai et al. (2006)	Continuous-flow	Amplification	- Sample actuation was not mentioned - Temperature control system consisting of heaters, thermal sensors, amplifiers, a microprocessor, and the control circuits
Obeid et al. (2003)	Continuous-flow	- Amplification - Detection	- Two syringe pumps - Four copper heat blocks - A laser-induced fluorescence system
Li et al. (2011)	Continuous-flow	- Amplification - Detection	- One syringe pump - Two cylindrical copper heaters - A fluorescence microscopy
Yamanaka et al. (2011)	Continuous-flow	- Amplification - Detection	- One microsyringe pump - Three heaters - One disposable electrical printed chip (for electrochemical detection)
Cao et al. (2012)	Continuous-flow	- Amplification - Detection	- Two syringe pumps - Two thin film heaters - A commercialized capillary electrophoresis system
Lien et al. (2007)	Chamber	- Sample concentration - Amplification	- Micropumps and microvalves - Microheaters, a micro temperature sensor, and an integrated circuit controller
Lee et al. (2008)	Chamber	- Amplification - Detection	- Syringe pump - Temperature control system with three infrared halogen lamps - Micro pinch valves - Image laser scanner and optical detection system with photodiodes and high-gain amplifier for chemiluminescence detection
Saunders et al. (2013)	Chamber	- Amplification - Detection	- Pump was not mentioned - Infrared laser system for temperature control - Inverted microscope
Liao et al. (2005)	Chamber	Amplification	- Micropumps and valves - Microheaters
Kaigala et al. (2008)	Chamber	- Amplification - Detection	- Pneumatically-actuated pumps and valves - Thin-film resistive element acting as a heater and a temperature sensor - Optical detection system including a laser diode and a charged coupled device camera for capillary electrophoresis
Hagan et al. (2011)	Chamber	- Sample purification - Amplification	- Syringe pump - Infrared-mediated heating for temperature control

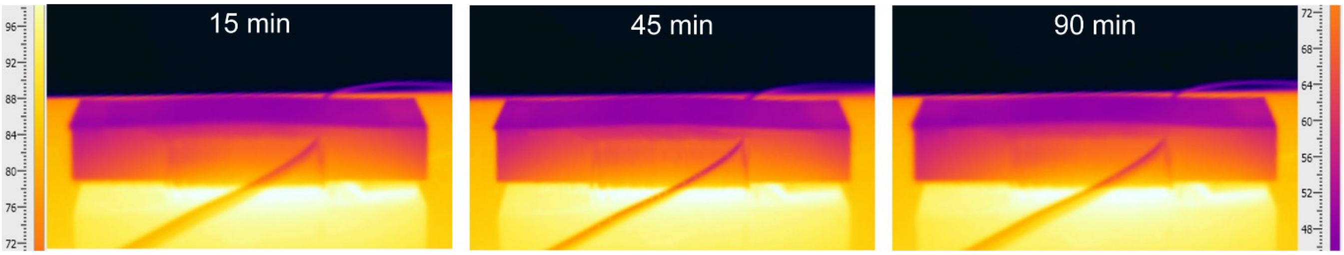

Fig. S1 Time-dependent temperature measurement of the 3D CF RT-PCR microdevice in 15, 45, and 90 min. The microdevice quickly reached the desired temperature within 15 min, and the designated temperature was stably maintained up to 90 min.

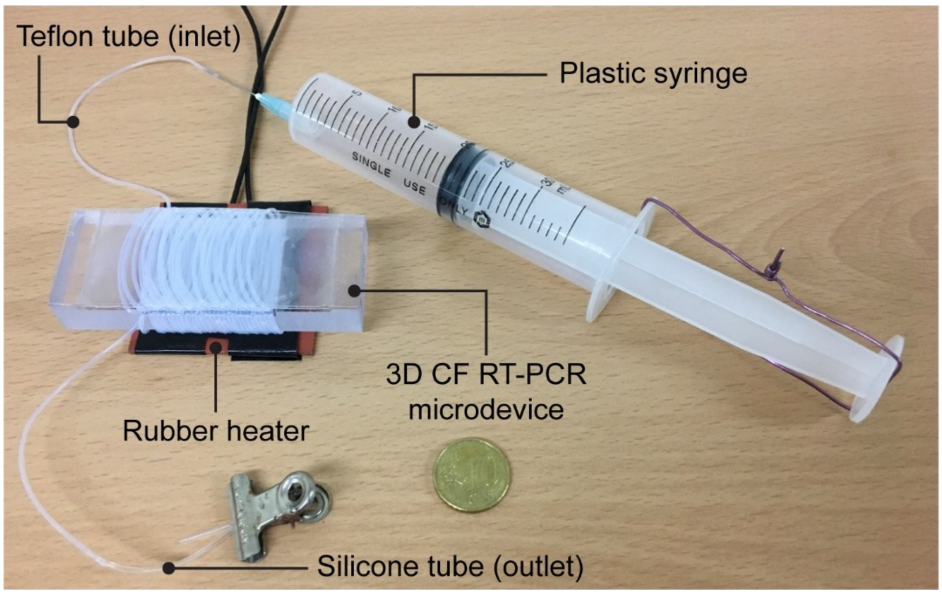

Fig. S2 Miniaturization of the heater used for the 3D CF RT-PCR. A lab-made rubber heater was used as the temperature source in replacement of the hot plate to enhance the portability of the entire system.

References

C. Zhang, D. Xing, *Nucleic Acids Res.,* 2007, **35**, 4223.

N. M. Toriello, E. S. Douglas, N. Thaitrong, S. C. Hsiao, M. B. Francis, C. R. Bertozzi, R. A. Mathies, *Proc. Natl. Acad. Sci. U. S. A.*, 2008, **105**, 20173.

I. Gustavsson, M. Lindell, E. Wilander, A. Strand, U. Gyllensten, *J. Clin. Virol.*, 2009, **46**, 112.

H. Laurell, J. S. Iacovoni, A. Abot, D. Svec, J.-J. Maoret, J.-F. Arnal, M. Kubista, *Nucleic Acids Res.,* 2012, **40**, e51.

P. J. Obeid, T. K. Christopoulos, *Anal. Chim Acta*, 2003, **494**, 1.

R. Hartung, A. Brösing, G. Sczcepankiewicz, U. Liebert, N. Häfner, M. Dürst, J. Felbel, D. Lassner, J. M. Köhler, *Biomed. Microdevices*, 2009, **11**, 685.

J. Felbel, A. Reichert, M. Kielpinski, M. Urban, T. Henkel, N. Häfner, M. Durst, J. Weber, *Chem. Eng. J.*, 2008, **135S**, S298.

N.-C. Tsai, C.-Y., Sue, *Biosens. Bioelectron.*, 2006, **22**, 313.

P. J. Obeid, T. K. Christopoulos, H. J. Crabtree, C. J. Backhouse, *Anal. Chem.*, 2003, **75**, 288

Y. Li, C. Zhang, D. Xing, *Microfluid. Nanofluid.*, 2011, **10**, 367.

K. Yamanaka, M. Saito, K. Kondoh, M. M. Hossain, R. Koketsu, T. Sasaki, N. Nagatani, K. Ikuta, E. Tamiya, *Analyst*, 2011, **136**, 2064.

Q. Cao, M. Mahalanabis, J. Chang, B. Carey, C. Hsieh, A. Stanley, C. A. Odell, P. Mitchell, J. Feldman, N. R. Pollock, C. M. Klapperich, *PLoS ONE*, 2012, **7**, e33176.

K.-Y. Lien, W.-C. Lee, H.-Y. Lei, G.-B. Lee, *Biosens. Bioelectron.*, 2007, **22**, 1739.

S. H. Lee, S.-W. Kim, J. Y. Kang, C. H. Ahn, *Lab Chip*, 2008, **8**, 2121.

D. C. Saunders, G. L. Holst, C. R. Phaneuf, N. Pak, M. Marchese, N. Sondej, M. McKinnon, C. R. Forest, *Biosens. Bioelectron.*, 2013, **44**, 222.

C.-S. Liao, G.-B. Lee, H.-S. Liu, T.-M. Hsieh, C.-H. Luo, *Nucleic Acids Res.*, 2005, **33**, e156.

G. V. Kaigala, V. N. Hoang, A. Stickel, J. Lauzon, D. Manage, L. M. Pilarski, C. J. Backhouse, *Analyst*, 2008, **133**, 331.

K. A. Hagan, C. R. Reedy, M. L. Uchimoto, D. Basu, D. A. Engel, J. P. Landers, *Lab Chip*, 2011, **11**, 957.