

A novel integrated microfluidic platform to perform fluorescence in situ hybridization for chromosomal analysis

Chien-Hsuan Tai · Chung-Liang Ho · Ya-Lan Chen ·
Wan Li Chen · Gwo-Bin Lee

Received: 24 October 2012 / Accepted: 8 April 2013 / Published online: 24 April 2013
© Springer-Verlag Berlin Heidelberg 2013

Abstract The fluorescence in situ hybridization (FISH) technique has been commonly employed to detect the chromosomal abnormalities. However, applications of this technique are limited due to its lengthy process and labor-intensive sample preparation. In this study, a novel integrated microfluidic chip capable of performing the entire FISH protocol automatically was reported. This novel technique can achieve several advantages, including reduce the consumption of bio-samples and reagents, automation and rapid analysis compared to the conventional method. In this study, several functional microfluidic devices were integrated on a single chip to perform automatic FISH on the microfluidic platform. Experimental data demonstrated that the developed microfluidic system successfully provided superior performance for probing the chromosomal abnormality of cells. Furthermore,

the novel microfluidic system performed the entire process automatically within 3 h, where the conventional method required 10 h to perform the entire protocol manually. This data indicated superior performance of the novel method. Our findings conclude that the novel integrated FISH protocol is more convenient to perform large quantities of samples, which can be used in clinical trials.

Keywords Chromosomal abnormality · FISH · Hybridization · Microfluidics · MEMS

Abbreviations

ATCC	American Type Culture Collection
Bio-MEMS	Bio-microelectromechanical systems
CNC	Computer numerical control
DAPI	4'-Diamidino-2-phenylindole
DC	Direct current
ddH ₂ O	Double-distilled water
EDTA-K3	Ethylenediaminetetraacetic acid tripotassium dihydrate
EMV	Electromagnetic valve
EtOH	Ethyl alcohol
FISH	Fluorescence in situ hybridization
PBMCs	Peripheral blood mononuclear cells
PBS	Phosphate-buffered saline
PDMS	Polydimethylsiloxane
PMMA	Polymethylmethacrylate
SSC	Sodium chloride–sodium citrate buffer
TE	Thermoelectric

The preliminary results for this paper have been presented at the 2012 IEEE International Conference on Microelectromechanical Systems (IEEE MEMS 2012), Paris, France, January 29–February 2, 2012.

C.-H. Tai
Department of Engineering Science, National Cheng Kung University, Tainan 70101, Taiwan

C.-L. Ho (✉) · Y.-L. Chen
Institute of Basic Medical Science, College of Medicine,
National Cheng Kung University, Tainan 70101, Taiwan
e-mail: clh9@mail.ncku.edu.tw

C.-L. Ho · W. L. Chen
Laboratory of Molecular Diagnostics, Department of Pathology,
National Cheng Kung University Hospital,
Tainan 70403, Taiwan

G.-B. Lee (✉)
Department of Power Mechanical Engineering, National Tsing Hua University, Hsinchu 30013, Taiwan
e-mail: gwobin@pme.nthu.edu.tw

1 Introduction

The fluorescence in situ hybridization (FISH) technique has been widely used to detect chromosomal-related genetic