A16-244
Application Group

驗一下吧！移動式疾病檢測機
Try it !A Portable Microfluidic Platform for Homecare Application

隊伍名稱　彈指之間 / BIOS TEAM
隊　　長　官大涵 / 臺灣大學電機工程學系
隊　　員　王義舜 / 臺灣大學電子工程學研究所
　　張哲斌 / 臺灣大學電機工程學系
　　蘇威宇 / 臺灣大學生醫電子與資訊學研究所

指導教授　林致廷 / 臺灣大學電子工程學研究所
　　黃念祖 / 臺灣大學生醫電子與資訊學研究所

作品摘要

血液中的各種生物標誌物可以反映健康狀況。通常醫生需要監控多個生物標誌物方能精確檢查的疾病狀態。例如，糖尿病的嚴重程度可以從糖化血紅蛋白和血紅蛋白的比例來確定。為了測量多個標記時，通常需要較大的血量（1-10mL）和多種儀器來處理樣品，並在不同的時間進行測量。因此，我們開發了一個多功能微流體控制平台，全血可在微流體通道中處理，糖化血紅蛋白和血紅蛋白可在平台上同時進行測量。由 PMMA 製成的微流體控制晶片可以進行血液稀釋，血細胞沉降和血漿的純化和稀釋；CMOS 矽晶片可以測量血紅蛋白和抗糖化血紅蛋白濃度。在這個平台上，只需要輸血量 5μL 和 15 分鐘進行測試。透過這個概念，所有的疾病生物標誌物可成功地監測。此外，再和其他無線傳輸整合，早期診斷和 POCT 的概念即可實現。

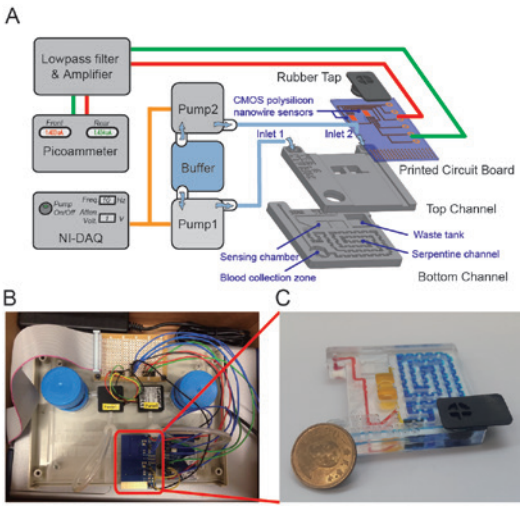

圖 1. (A) 感測平台由 (1)PMMA 微流體晶片 (2) 微幫浦 (3)CMOS 奈米線感測晶片所組成 (B) 感測平台之照片 (10x10x5cm^3)(C)PMMA 微流體晶片之照片 / (A) Schematic of the MINS system, consist of (1) the PMMA microfluidic chip; (2) two piezoelectric micropumps; (3) dual CMOS silicon nanowire sensors. (B) The photo of the MINS platform. The size is 10x10x5cm^3 (C) The photo of PMMA microfluidic chip. Thesize of the PMMA microfluidic chip is 10x10x4 mm.

Abstract

The average life expectancy of human beings has been increased thanks to technologies and medical standards being continuously improved. However, it is inevitable that more and more people were suffered from modern civilized illness, such as cardiovascular diseases, diabetes and cancer, when entering an aging society.

Hemoglobin-A1c test, measuring the ratio of glycated hemoglobin (HbA1c) to hemoglobin (Hb) level, has been a standard assay in diabetes diagnosis and monitoring without day-to-day glucose level variation. Currently, HbA1c test can only be done in the hospitals or central laboratories due to laborious and time-consuming whole blood processing. In this work, we have developed a microfluidic device integrated dual CMOS polysilicon nanowire sensors (MINS) to perform on-chip whole blood processing and detection of Hb and HbA1c. The PMMA microfluidic device was designed for non-lysed cells or debris trapping, uniform plasma / buffer mixing and dilution.

The CMOS fabricated polysilicon nanowire sensors were used for multiple analytes. Our work first measured Hb and HbA1c level in 3 clinical samples by nanowire sensors. The results were compared by the standard Hb and HbA1c measurement methods and showed comparable results. Finally, we demonstrated the MINS device can successfully perform on-chip whole blood processing followed by simultaneous detection of Hb and HbA1c in the clinical sample.

Compared to current instruments, the overall size of MINS platform is relatively small and can simultaneous detect two analytes with only 5 μL whole blood requirement, which is 300-fold blood volume reduction. The total assay time was just 30 minutes. Based on its on-chip whole blood processing and multiple analytes detection functionality with a lower sample volume requirement and shorter process time, the MINS device can be effectively applied for real-time diabetes diagnostics and monitoring in point-of-care settings.