学 位 論 文 審 査 の 要 旨

博士の専攻分野の名称　博士（総合化学）　氏名　サイード モハンマディ

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学 位 論 文 題 名

Development of Microfluidic Paper-Based Analytical Devices (µPADs) for Detection of Biomarkers
（バイオマーカー検出のためのマイクロ流体ペーパー分析デバイスの開発）

Microfluidic technology has evolved over the past few decades from a molecular analysis endeavour aimed at enhancing separation performance through reduced dimensions, into a diverse field influencing an ever-expanding range of disciplines. Microfluidic techniques are being employed in chemistry, biology, pharmacy medicine, homeland security, and other areas where their inherent advantages trump standard methodologies. Since the last decade, new generation of microfluidic devices which are termed microfluidic paper-based analytical devices (µPADs) have gained great attention in many fields such as point of care diagnosis, environmental testing, and food analysis. These devices have numerous advantages, including low-cost fabrication, facile application, portability, and environmental compatibility. In this study new techniques have developed to fabricate a µPAD and to utilize the fabricated µPAD for detection of biomarkers.

The thesis includes 5 chapters. First chapter describes the general introduction of what microfluidic technology and µPADs are and recent development of fabrication methods. In current chapter advantages and disadvantages of µPADs have been studied.

Chapter 2 describes a simple and instrument-free screen-printing method to fabricate hydrophilic channels by patterning polydimethylsiloxane (PDMS) onto chromatography paper. First, the minimum width of the printed channel to deliver an aqueous sample was studied. Fabricated µPADs were tested for several colorimetric assays of pH, glucose, and protein in both buffer and simulated urine samples and results were obtained in less than 30 min.

Chapter 3 proposes a novel technique based on spontaneous capillary force of paper substrates for µPADs to eliminate unbound antigen and antibodies in an enzyme linked immunosorbent assay (ELISA). This study demonstrates that introduction of the washing technique will allow use of the µPADs as the lowest cost platform of microfluidic devices with high reproducibility and sensitivity. As an assay model, C-reactive protein (CRP), a biomarker of inflammation, was detected with a limit of detection (LOD) of 5 µg/mL.

Chapter 4 describes the development of a µPAD which is a rapid, user friend, cost effective, and portable device to detect cat cystatin C (cCys-C). Since increasing of cystatin C in blood stream leads to irreparable renal disorders in pets, especially in feline, develop a facilitated technique for renal disorder diagnosis is extremely desired. At the first, cCys-C was detected using conventional microtiter plate. Next, we used a new detection system for cCys-C by

a microfluidic device that termed immuno-pillar chip. In contrast with conventional 96 microtiter plate, the volume of reagent was significantly decreased from 100 µL to 0.5 µL. In addition, total analysis time was declined from 240 min to 20 min. Then, the background knowledge in this research is used to develop a new system to detect cCys-C using a µPAD. Finally, chapter 5 summarizes this study.

The final chapter is the summary of the findings in the present research. In addition, several prospects on µ PAD analysis for future research are described in this chapter.

Based on the review and interview of the doctor thesis, this study can be judged to be very significant and valuable from the viewpoints of scientific research and application potential. Ph.D. degree in Chemical Sciences and Engineering should be awarded to the candidate.