



Leading the Next

# A World-to-Chip Microfluidic Interconnection Technology with Dual Functions of Sample Injection and Sealing for a Multichamber Micro PCR Chip

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## Abstract

This paper presents a practical world-to-chip microfluidic interconnection technology with dual functions of sample injection and sealing for a multichamber Micro PCR (Polymerase Chain Reaction) chip. After sample injection and sealing, leakage tests were conducted by elevating the temperature upto 100 °C for 30 min. No leakage flows were found during the test for 10 cartridges. In conclusion, we have introduced a simple and cheap microfluidic interconnection technology for both sample injection and sealing, which provides a zero dead volume, a zero leakage flow, and biochemical compatibility. Also, this world-to-chip interconnection technology enables one or more operators to interface between the micro world and real world easily by using conventional pipettes.

## Introduction

### World-to-Chip Microfluidic Interconnection

- ▶ Easy coupling between micro scale in the microfluidic device and macro scale in the real world

### Sample Injection into Microfluidic Biochips

- ▶ Less dead volume
- ▶ No air bubble generation during injection
- ▶ No contamination between samples
- ▶ Easy coupling with the real world (pipette tips, luer fittings, tubes...)

### Sealing/Valving for Microfluidic Biochips

- ▶ Withstanding of the internal pressure due to thermal cycling
- ▶ Biochemical-compatible materials
- ▶ Re-opening of the valves after PCR, to allow PCR solution to flow into downstream for further detection and analysis

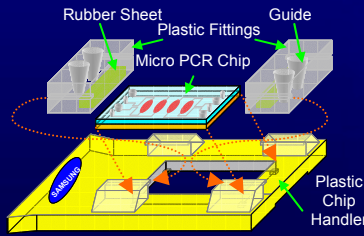
## Our Approach

### Cartridge for Dual Function

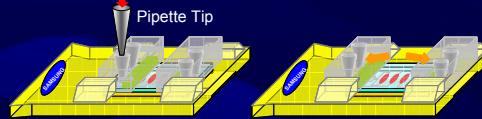
- ▶ Sample injection + sealing
- ▶ For multichamber Micro PCR chips
- ▶ For user-friendly chip handling

### Sample Injection + Sealing (or Valving)

- ▶ Pipette tip guiding
- ▶ Rubber sealing
- ▶ Easy alignment
- ▶ Valves for inlets/vents
- ▶ No contamination
- ▶ No leakage flows



Assembly process of a cartridge



A mode for pipette tip guiding and sample loading

The other mode for sealing or valving of inlets/vents



A Micro PCR chip



The cartridge with the chip

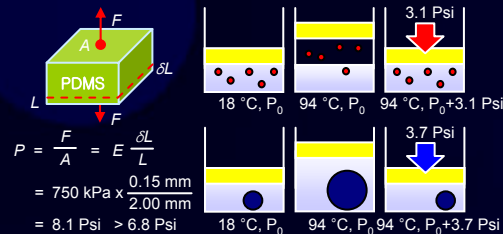
## Design

### Rubber Sheets (PDMS)

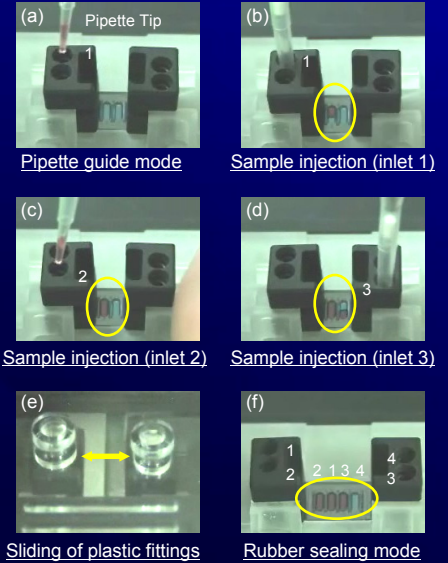
- ▶ 8.1 Psi > 6.8 Psi

### Withstanding of the total internal pressure (~6.8 Psi)

- ▶ Pressure to prevent degassing: ~3.1 Psi (by Henry's law: gas solubility ∝ the partial pressure of the gas above the solution)
- ▶ Additional pressure in the presence of air bubbles (in worst case): ~3.7 Psi at 94 °C (by ideal gas law)

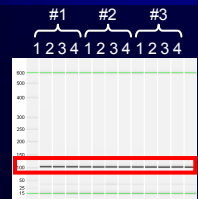


## Demonstration



## Evaluation of Leakage during PCR

- ▶ No leakage flows during thermal cycling
- ▶ Gel electrophoresis results showing the 6.7 % CV of PCR yield of 3 Micro PCR chips (12 microchambers)



## Conclusions

### Simple and Cheap World-to-Chip Microfluidic Interconnection Technology

- ▶ For both sample injection and sealing
- ▶ Providing a zero dead volume, a zero leakage flow, and biochemical compatibility
- ▶ Interfacing between the micro world and the real world easily

### Tremendous Applications in Biochemical μTAS

46" high x 47" wide  
117 cm x 120 cm  
18.58 cm x 19.06 cm