

## Micropumping of Liquids by Directional Growth and Selective Venting of Bubbles

Tech ID: 20152 / UC Case 2005-408-0

### SUMMARY

UCLA researchers in the Department of Mechanical and Aerospace Engineering have invented a micro-scale pumping mechanism that requires no moving parts, operates on low power, and offers greater utility than the present state of the art for both open and closed systems.

### BACKGROUND

Micropumps are a critical element of microfluidics, as they are required to move small volumes of liquid in a controlled, energy-efficient manner. Several categories of micropumps have been reported, such as mechanical micropumps, electrokinetic micropumps, and valveless bubble-driven micropumps. The valveless bubble pumps are attractive for microfluidics because of their simplicity in fabrication over mechanical pumps and their flexibility in working liquids over electrokinetic pumps. The preferred method to date of generating bubbles in the valveless pump is by thermal generation (boiling). However, this method has several limitations. First, boiling requires high levels of energy to induce vapor formation. Second, the vapor condenses back to liquids much slower than they boiled, which limits the cycling speed of the pumping action. Another common bubble generation methods for the valveless pump is electrolysis, but they are not suitable for closed systems, such as fuel cells, because of the inability to eliminate the gas bubbles.

### INNOVATION

This invention provides a compact means to pump a liquid in a microfluidic system by generating, moving, and quickly removing gas bubbles from the system with low power. With existing technology, bubble-driven pumps are made open so that bubbles are expelled with the liquid. In contrast, this invention vents the bubbles (without liquid) quickly through a nano-porous membrane making it applicable in both open and closed fluidic devices.

### APPLICATIONS

- ▶ Small fuel cells
- ▶ Chromatography
- ▶ Biological and chemical sensors
- ▶ Lab-on-a-chip microfluidic circuits
- ▶ Drug delivery systems such as insulin pumps

### ADVANTAGES

- ▶ Compact design with no moving parts
- ▶ Low energy consumption
- ▶ Biocompatible
- ▶ Applicable in both open and closed-loop fluidic systems
- ▶ Works with virtually any means of gas bubble generation (e.g., electrolysis, gas injection, chemical reaction, and cavitation)

### STATE OF DEVELOPMENT

A device has been fabricated, tested, and characterized in both closed-loop and open-loop configurations.

### CONTACT

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### INVENTORS

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### OTHER INFORMATION

#### KEYWORDS

microfluidics biosensor, bubbles,  
valveless, pumping, fluid flow, nano-  
porous, membrane

#### CATEGORIZED AS

- ▶ **Semiconductors**
- ▶ Other
- ▶ **Engineering**
- ▶ Other

#### RELATED CASES

2005-408-0

## OTHER INFORMATION

**ABOUT THE LAB:** This innovation is generated by the UCLA Micromanufacturing Laboratory at UCLA. Current research projects in the lab include digital microfluidics, nanoengineered surfaces, microdroplet-dispensing systems, RF liquid switches, micro fuel cells, 3-D microbatteries, and on-chip encapsulation of microdevices.

**Website:** <http://cjmems.seas.ucla.edu/>

## PATENT STATUS

Country	Type	Number	Dated	Case
United States Of America	Issued Patent	7,976,286	07/12/2011	2005-408

## ADDITIONAL TECHNOLOGIES BY THESE INVENTORS

- ▶ Membraneless Fuel Cell with Self-Pumped Fuel and Oxidant
- ▶ Methods of Restoring and Maintaining Gas Film on Superhydrophobic Surfaces while Underwater
- ▶ A Low-Profile Flow Shear Sensing Unit
- ▶ Complete Transfer of Liquid Drops by Modification of Nozzle Design
- ▶ Stereo Image Acquisition By Lens Translation
- ▶ Method of Fluid Manipulation By Electrodewetting
- ▶ Method for Commercial Production of Super-Hydrophobic Materials
- ▶ A Built-In Mechanism Of Gas Maintenance In Microfeatures On A Submerged Surface
- ▶ No-Assembly Devices for Microfluidics Inside a Cavity
- ▶ Liquid-Repellent Surfaces Made of Any Materials
- ▶ On-chip, Real-time Feedback Control for Electrical Manipulation of Droplets
- ▶ Microstructured Cathode for Self-Regulated Oxygen Generation and Consumption

## Gateway to Innovation, Research and Entrepreneurship

### UCLA Technology Development Group

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