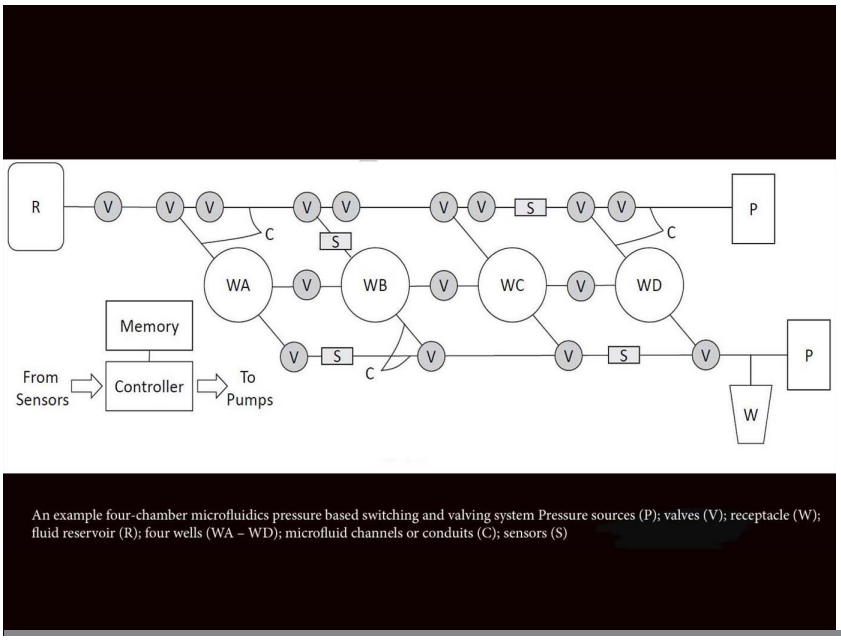


An example four-chamber microfluidics pressure based switching and valving system Pressure sources (P); valves (V); receptacle (W); fluid reservoir (R); four wells (WA – WD); microfluid channels or conduits (C); sensors (S)

National Aeronautics and Space Administration

TECHNOLOGY SOLUTION

Mechanical and Fluid Systems

Microfluidics Pressure-Based Switching and Valving Array

Automation and miniaturization of complex microfluidics laboratory techniques on a single chip

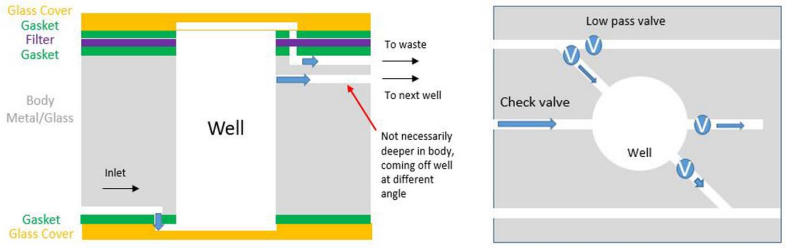
Traditionally, laboratory operations in fields such as molecular biology and organic chemistry have required “humans in the loop,” a major inefficiency source and bottleneck for automation. Many lab-on-a-chip devices are designed to perform specific tasks, and do not offer programmable movement of microfluidic-well contents or application-specific reconfigurability. NASA Ames’ researchers have developed a novel method that acts as a microfluidic switch array, determining flow paths using specific logic states achieved through the application of different combinations of pressure and flow conditions to specified valves. This technology facilitates automation of complex laboratory techniques by enabling the programming of any number of sequences by which the contents of microfluidic wells are automatically transferred to specified neighboring chambers, in ways not possible with earlier NASA automated microfluidics technologies.

BENEFITS

- Automation of multi-step microfluidics protocols: sequential movement of well contents enables automation of complex laboratory techniques on a single chip
- The movement of well contents can be implemented, and, later changed, through simple programming, so the end user can automate any number of protocols on a single chip
- Miniaturization: small form factor is achieved by reducing the number of large solenoid valves necessary in multi-step microfluidics systems
- The design supports a variety of generational biological experiment possibilities
- The microfluidic card design uses pressure-based actuation of an addressable array of sealing features to transfer samples from one well to another in a stepwise fashion

THE TECHNOLOGY

The innovative technology from Ames acts as a microfluidics switch array, using combinations of pressure and flow conditions to achieve specific logic states that determine the sequences of sample movement between microfluidic wells. This advancement will enable automation of complex laboratory techniques not possible with earlier microfluidics technologies that are designed to follow predetermined flow paths and well targets. This novel method also enables autonomous operations including changing the flow paths and targeting well configurations in situ based on measured data decision parameters. This microfluidic system can be reconfigured for use in various experimental applications, requiring only an adjustment of the programmed pressure sequencing, reducing the need for custom design and development for each new application. For example, this technology could provide the ability to selectively constrain or move biological specimens in the experimental wells, allowing evolutionary studies of model organisms in response to various stressors, evaluation of different growth conditions on biological production of antibodies or other small molecule therapeutics, among other potential applications. Likewise, this platform can be used to foster time-dependent, step-wise, chemical reactions, which could be used for novel chemical processes or in situ resource utilization.



An example of a well constructed in a microfluidics card in an elevational cross-section view. Left: plan cross-section view Right: in a two-way valve configuration.

APPLICATIONS

The technology has several potential applications:

- Biotechnology industry
- Chemistry and Life Sciences industries
- Automating laboratory operations such as genomic analysis, drug screening/discovery, high-throughput cellular analysis, automated sample processing, and next-generation sequencing
- Chemical mixing industry
- Radiation exposure industry
- Photochemistry and photobiology industry
- Space and ground sequential biology and/or chemistry experiments not possible with current microfluidic cards

PUBLICATIONS

Patent Pending

More Information

National Aeronautics and Space Administration

Agency Licensing Concierge

Ames Research Center

MS 202A-3
Moffett Field, CA 94035
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www.nasa.gov

NP-2015-05-1890-HQ

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