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Piezoelectric Micro/Nanoliter Droplet Dispenser

► Piezoelectric Microdispenser

Piezoelectric Pumps

► Piezoelectric Valves

Piezoelectric Valves

JAMES FRIEND, LESLIE YEO
MicroNanophysics Research Laboratory, Monash University, Clayton, VIC, Australia
james.friend@eng.monash.edu.au,
leslie.yeo@eng.monash.edu.au

Synonyms

Microvalve; Piezoelectric pumps; No-moving-part valves

Definition

Structures that regulate the flow of fluids using piezoelectric materials, either composed of active regulation through deflection of a structure to block or allow passage of the fluid using electrically-driven piezoelectric elements, or as a piezoelectric pump in combination with mechanical or passive diffuser valves.

Overview

Active piezoelectric valves offer a unique combination of large closing forces – hundreds to thousands of newtons – against fluid loads and small displacements measured in the tens of microns. Such valves may be designed to close or open upon the application of an electric field to the piezoelectric material, and offer flow rates from nearly arbitrarily low amounts to tens of liters per minute for gases, water, and similar fluids [1]. Given the limited strain, 0.1% or less, available from typical high-performance piezoelectric ceramic materials, a majority of the research and development effort has been in amplifying this strain to permit efficient valving action. Flap or cantilever valves seated across an orifice actuated as a piezoelectric ► bimorph or ► unimorph or ball or grooved structures seated against an orifice and moved using a large-displacement ► linear multilayer piezoelectric actuator is typical of this approach.

Passive piezoelectric valves function in an entirely different manner, though they also make use of piezoelectric bimorph or unimorph structures. Forming one side of a small fluid chamber, or ► Helmholtz cavity, the piezoelectric element can excite chamber resonances when driven at appropriate frequencies via an oscillatory electric field, usually from 10 Hz to 100 kHz depending on the device dimensions and fluid. With two or more orifices connecting the chamber to the outside, fluid may be passed into and out of the chamber; by using orifices with different shapes the flow direction may be regulated without requiring a mechanical blockage of the flow [2] or moving parts. Though these configurations are effective as pumps [3], they also can serve as valves for applications where some leakage is tolerable, or where ball or flap valves may be used as passive mechanical restrictions on the orifices to augment the sealing action and improve performance.

Cross References

► Piezoelectric Microdispenser
► Piezoelectric Materials for Microfluidics

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► Picoliter Flow Calibration