Advanced simulation for actuation control of smart microfluidic valves

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ABSTRACT

Several concepts have been developed for actuation of microvalves [1] in order to fulfill multiple desired characteristics such as the reduction of flow leakage and power consumptions, improved response time, high work density and ability to operate with both liquids and gases.

Shape memory alloys (SMA) are a class of smart materials operating with thermal microvalves type. They allow simple and compact structures with high output forces [2-3] and can control high pressure differences. While they include relatively slow actuation speed and high-power consumption due to temperature changes. We present an introduction to micro-scale valves, their advantages and downsides, and a review of the shape memory alloys (SMA) microvalve design given by Dolphin Fluidics company.

We present relevant methodologies and techniques to study the microvalve model developed by Dolphin Fluidic company, several computational fluid dynamics (CFD) simulations to describe the fluid behavior during valve opening/closing phases, the numerical solutions proposed for the boundary conditions and iteration schemes used depending on the flow regime and fluid type. Finite Volume Method (FVM) is used to discretize the model through ANSYS Fluent solver to study the fluid behavior, including pressure differences, velocity and forces at boundaries. The preliminary analysis and results discussed may be useful for future optimization processes.

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