# Analysis of Fluid Pumping with a Throttle Type Piezoelectric Micro Pump

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## Abstract

Several types of micro pumps were proposed in the last few years based on various actuating principles and fabricated by different MEMS technologies [1,2,3]. However, many of these micropumps were designed without appropriate pump performance analysis. As a support for the micropump design and fabrication, a complete electro-fluid-solid mechanics coupling model for numerical simulation of piezoelectric micropumps has been developed using finite element analysis software COMSOL Multiphysics. Fluid flow is modeled using Navier-Stokes equations which is simplified due to low Reynolds number, resulting in a model of creeping flow that does not take into account fluid inertion. Piezoelectric actuator deformation by applied excitation signal is modeled by a coupled electro-structural mechanics model in which a coupling matrix takes into account deformation dependence on the direction of the electric field. A full 3D modeling was required due to complex design geometries. This complicates numerical analysis as the total dimensions of the simulation structure are large in comparison with several local miniature details that have to be taken into account, such as microthrottles, diffusers, etc. As a consequence, very dense simulation mesh is required in these areas. The final discretization of the model results in a very large number of mesh points leading to large computational requirements, therefore, further modeling optimization is needed, such as fine tuning of several simulation parameters e.g. boundary conditions, physic-model simplifications as well as optimizations of numerical solvers. This will be discussed in more detail in the full paper. Taking into account all above mentioned restrictions we successfully modeled operation of a piezoelectric micropump using sinusoidal excitation signal. Figure 1 presents maximal deformation of a piezoelectric actuator and a membrane with a color scale, representing mesh displacement. Time dependent fluid flow at the channel outlet as a consequence of sinusoidal excitation signal is shown in Figure 2.

## Reference


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## Figures used in the abstract

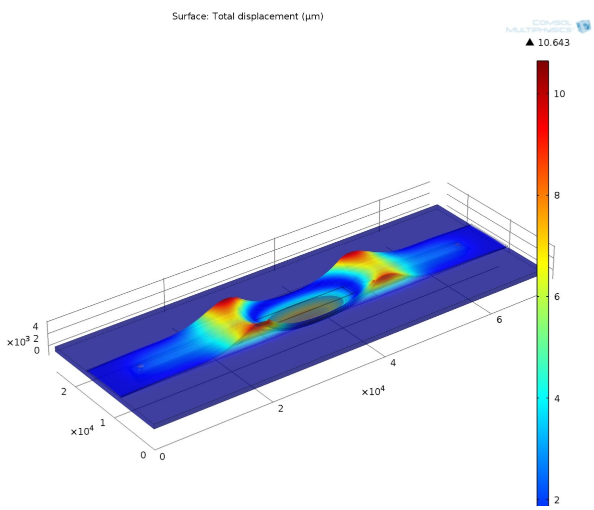


**Figure 1**: Maximal deformation of piezoelectric actuator and membrane.

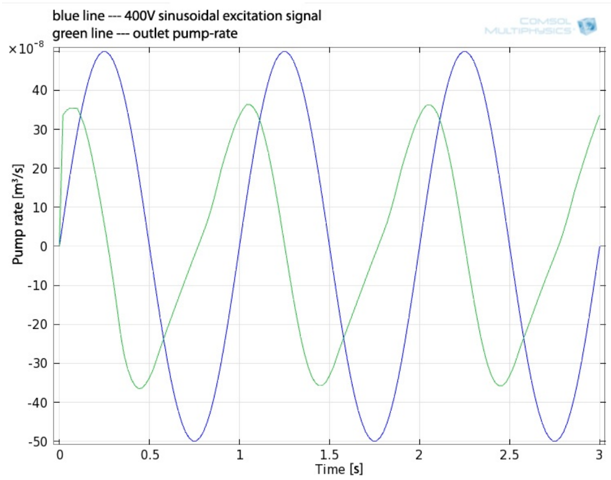


**Figure 2**: Time dependant fluid flow at channel outlet as a consequence of sinusoidal excitation signal.