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Modeling of an Insulin Mircopump

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Abstract : Many people suffer from diabetes, a disease marked by abnormal levels of sugar in the blood; 285 million people have diabetes, 6.6% of the world adult population (in 2010), according to the International Diabetes Federation. Insulin medicament is invented to be injected into the body. Generally, the injection requires the patient to do it manually. However, in many cases he will be unable to inject the drug, saw that among the side effects of hyperglycemia is the weakness of the whole body. The researchers designed a medical device that injects insulin too autonomously by using micro-pumps. Many micro-pumps of concepts have been investigated during the last two decades for injecting molecules in blood or in the body. However, all these micro-pumps are intended for slow infusion of drug (injection of few microliters by minute). Now, the challenge is to develop micro-pumps for fast injections (1 microliter in 10 seconds) with accuracy of the order of microliter. Recently, studies have shown that only piezoelectric actuators can achieve this performance, knowing that few systems at the microscopic level were presented. These reasons lead us to design new smart microsystems injection drugs. Therefore, many technological advances are still to achieve the improvement of materials to their uses, while going through their characterization and modeling action mechanisms themselves. Moreover, it remains to study the integration of the piezoelectric micro-pump in the microfluidic platform features to explore and evaluate the performance of these new micro devices. In this work, we propose a new micro-pump model based on piezoelectric actuation with a new design. Here, we use a finite element model with Comsol software. Our device is composed of two pumping chambers, two diaphragms and two actuators (piezoelectric disks). The latter parts will apply a mechanical force on the membrane in a periodic manner. The membrane deformation allows the fluid pumping, the suction and discharge of the liquid. In this study, we present the modeling results as function as device geometry properties, films thickness, and materials properties. Here, we demonstrate that we can achieve fast injection. The results of these simulations will provide quantitative performance of our micro-pumps. Concern the spatial actuation, fluid rate and allows optimization of the fabrication process in terms of materials and integration steps.

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