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Improved electro-conjugate fluid jet generator with bypass micro-channel

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An electro-conjugate fluid (ECF) is a kind of liquid dielectrics with excellent electrohydrodynamic characteristics. A powerful ECF jet flow will be generated between positive electrode and minus electrode subjected to high DC voltage. The jet generator that takes ECF as operating fluid features direct energy conversion, simple structure as well as low noise and vibration. Thanks to the MEMS (micro electro mechanical system) technology, the integrated fabrication of conductor layer, electrode pairs and flow channel layer in the jet ECF generator can be realized, which enables the ECF jet generator with smaller size, better fabrication quality and higher power density ratio. Currently, the ECF jet generator has been applied to ECF micropumps and bionic fingers.

With regard to the output of ECF jet generator, a phenomenon of unstable output pressure in pressure-holding condition was appeared in the experiment. In consideration of the possible problems in thermodynamic stability of ECF and the electrical stability in the ECF during long running of ECF jet generator, a bypass micro-channel is designed between the inlet and outlet of the channel in the channel layer. The bypass micro-channel will maintain a stable ECF flow inside the ECF jet generator in pressure-holding condition, which will reduce or remove the problems mentioned above and in that way improve the output stability of ECF jet generator.

The fabrication of improved ECF jet generators with bypass micro-channel based on MEMS technology has been completed. The fabricated jet generators have less defects and good appearance and are completely satisfied for present experiment. Unfortunately, the experimental performance evaluation of these ECF jet generators is still ongoing and will be finished in recent days. This study will favor the study of ECF bionic fingers.

Keywords: electro-conjugate fluid; jet generator; output stability; bypass micro-channel; MEMS

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带有旁路微流道的改进型电共轭流体射流发生器

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电共轭流体（electro-conjugate fluid）是一种具有良好电流体动力学特性的液体电介质，当浸入电共轭流体的金属电极对被施加直流高压时，电极间的电共轭流体将产生定向流动而产生射流，这种现象被称作电共轭效应。以电共轭流体为工作液体，基于电共轭效应实现液体增压的射流发生器具有结构简单，能量转换效率高，功率密度大，无噪声等优点。微机电系统（MEMS）技术的应用，实现了电共轭流体射流发生器中导电带、电极对（阵列）以及流道层的一体化制作，促进了射流发生器的微型化，提高了其制作质量和输出性能。目前，电共轭流体射流发生器在电共轭流体微型泵以及仿生学微手指中得到了很好的应用。

然而，在保压工况下，当前结构的射流发生器存在输出压力不稳定的现象。通过探讨及分析射流发生器长时间工作后，电共轭流体的热力学稳定性以及直流高压电场的稳定性等方面的原因对射流发生器输出稳定性的影响，本文设计一旁路微流道来连接原射流发生器流道的入口和出口，以保证在保压工况下，射流发生器内部能够维持稳定的电共轭流体流动，从而减轻或消除上述因素的影响，提高射流发生器的输出稳定性。

带有旁路微流道的改进型射流发生器的 MEMS 制作已经完成，制备的射流发生器侧壁陡直，结构完整，形貌质量好，制作质量完全满足实验要求。目前，对该改进型射流发生器输出特性的测试实验正在进行中，将于近日完成。本文的研究目的在于改善射流发生器的输出稳定性，其研究成果将为仿生学微手指的研究提供帮助。

关键词：电共轭流体；射流发生器；输出稳定性；旁路微流道；微机电系统