Valveless membrane pump for transdermal injection and aspiration

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A transdermal drug delivery system has been proposed wherein the drug is administered continuously over a longer period of time (>1 hrs). The system is based on an array of hollow silicon microneedles in combination with a pump and reservoir. The system would be small and lightweight, easy to operate and administer, provide a controllable rate of injection and relatively cost effective. The system could also be used in reverse to aspirate fluids from subcutaneous tissue.[1]
Infusion pumps are used for many clinical applications, including intravenous, epidural, and subcutaneous delivery of analgesics and anesthetics, antibiotics, cardiovascular drugs, and insulin. Drug delivery via infusion reduces the plasma drug concentration fluctuation associated with oral delivery and the slow onset and long depot effect associated with transdermal patch delivery. Infusion pumps are commonly used when continuous, intermittent, or pulsatile delivery of drug is needed. They also provide an alternative for patients intolerant to oral administration and can be programmed to achieve special delivery profiles. The use of infusion pumps outside the clinical setting has been limited by the device' bulky size and high cost as well as its low patient compliance because of the inconvenience of an indwelling catheter that has a relatively large infusion set and the expertise required to properly use it.[2]
This research focuses on the design of a valveless membrane pump for transdermal injection and aspiration. The advantages and disadvantages of the valveless membrane pump are discussed and a theoretical model is provided. A prototype valveless membrane pump has been fabricated and tested. A parametric study is performed using finite element analysis to optimize the design. These simulations are compared to the operation of the prototype using measurements of the flow characteristics and membrane vibration. As a summary, the optimized model of the valveless membrane pump is assessed for transdermal injection and aspiration.

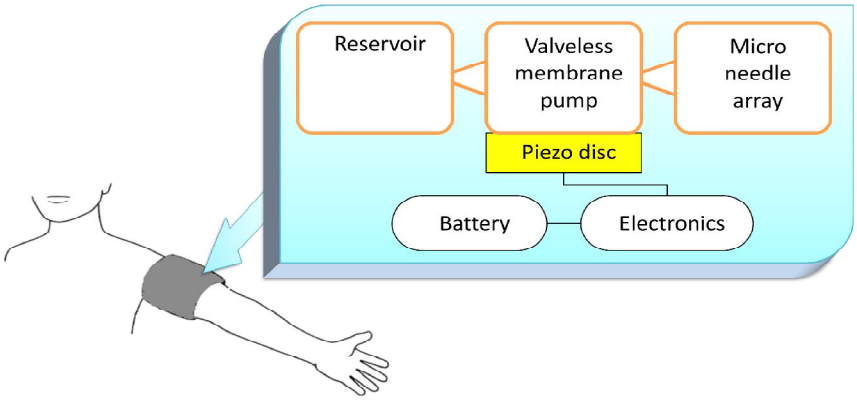

Figure 1: Concept for a time-controlled, transdermal drug delivery system

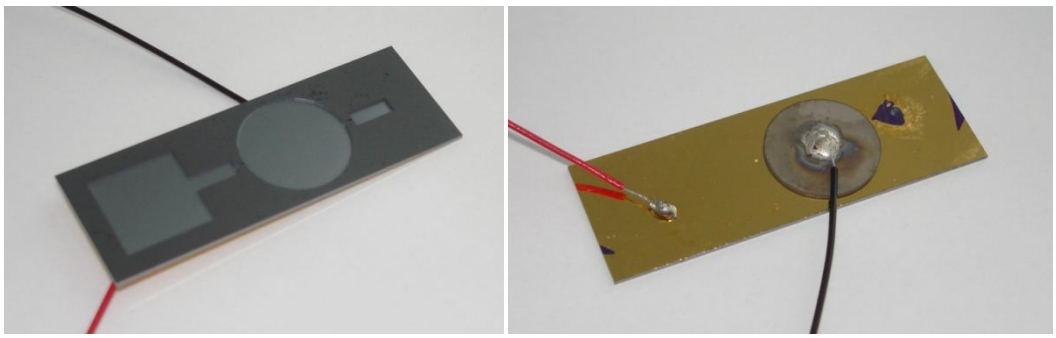

Figure 2: Prototype of a valveless membrane pump with Piëzo disc actuator, inlet channels not yet added

References

[1] Cui Q, Liu C, Zha XF. Study on a piezoelectric micropump for the controlled drug delivery system. *Microfluid. Nanofluid.* 3 (2007), pp. 377–390

[2] Martanto W, Davis SP, Holiday NR, Wang J, Gill HS, Prausnitz MR. Transdermal Delivery of Insulin Using Microneedles in Vivo. *Pharm Res.* 2004;21(6):947–52.