Design of Microneedle Array for Biomedicine

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Abstract

Micro electro-mechanical system (MEMS) is rapidly growing area of interest for a broad spectrum of applications. One particularly fast-growing area is biomedical applications for micromaching technologies. One application of interest to the biomedical industry is the development of microneedles. MEMS technology brings new means for biomedicine field.
Patch-based transdermal drug delivery offers a convenient way to administer drugs without the drawbacks of standard hypodermic injections relating to issues such as patient acceptability and injection safety. However, conventional transdermal drug delivery is limited to therapeutics where the drug can diffuse across the skin barrier. By using miniaturized needles, a pathway into the human body can be established which allow transport of macromolecular drugs such as insulins or vaccines. These microneedles only penetrate the outermost skin layers, superficial enough not to reach the nerve receptors of the lower skin. Thus, microneedle insertions are perceived as painless. The project presents work in the field of microneedle-based drug delivery with the specific aim of investigating a microneedle-based transdermal patch concept. To enable controllable drug infusion and still maintain an unobtrusive and easy-to-use, patch-like design. The needles are organized in arrays situated on a chip. To allow active delivery, the microneedles are hollow with the needle can have a cylindrical shape and tapered tip. The project work presents simulation and analysis of microneedle array using COMSOL Multiphysics 4.2. Study the evaluation of both the microneedle structure and the transdermal patch, issues such as penetration reliability, liquid delivery into the skin. This project addresses the characteristics of micro-needles are far more reliable. Drug delivery and Fluid extraction requirement in terms of minimal needle dimensions and force withstanding capabilities, which are inversely related to each other. The strength of the micro-needles has been examined analytically and modeled using finite element modeling tool COMSOL Multiphysics 4.2. Through performance analysis it is shown that the design is a significant improvement over existing needles.

Reference

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