Design of Microneedle for Biomedicine

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Introduction: MEMS technology brings new means for biomedicine field. One application of interest to the biomedical industry is the development of microneedles.

Patch-based transdermal drug delivery offers a convenient way to administer drugs without the drawbacks of standard hypodermic injections.

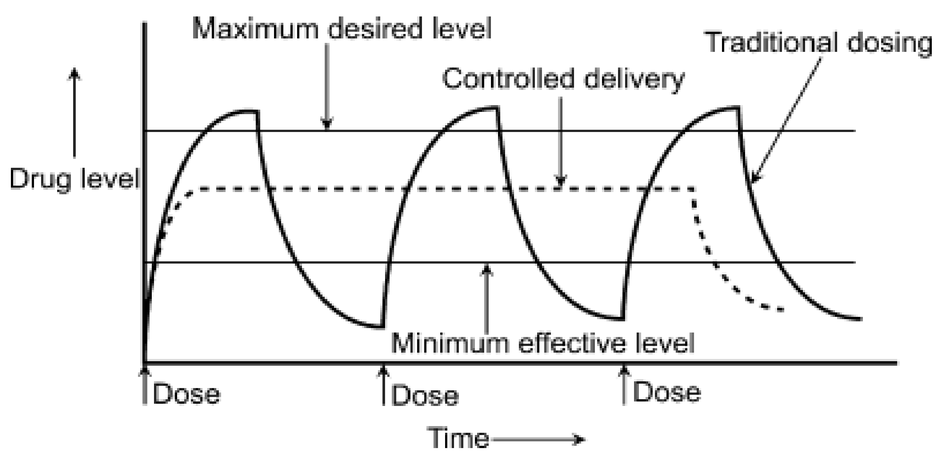

Fig: Drug Dosing System

This study present in the field of microneedle-based drug delivery with the specific aim of investigating microneedle-based transdermal patch concept.

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. This study presents simulation and analysis of microneedle array and evaluation of both the microneedle structure and the transdermal patch, issues such as penetration reliability, liquid delivery into the skin.

Computational Methods:

- Applied Axial Force>Resistive Force (Axial force apply on tip)
- Axial force =Compressive force
- Fcompressive =Yield Strength* Area

Theoretically human skin resistance is 3.18 MPa while penetrating the skin.

$F_{Skin} = P_{Piercing} A$

where,

Piercing P=Pressure required to pierce the epidermis layer of skin=3.18 × 10^6 Pa.

A = cross-sectional area of the needle.

Results:

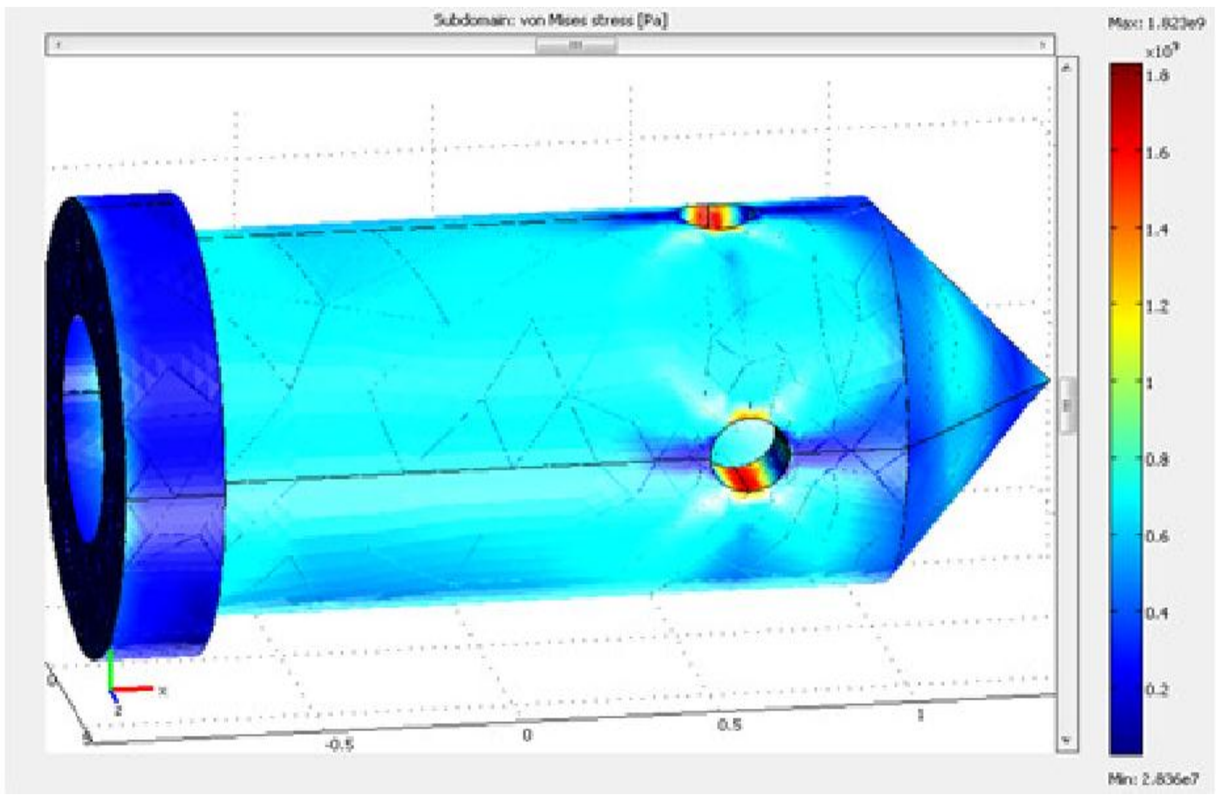

Fig: Maximum stress for buckling and bending forces

Conclusions:

This project work addresses the issues related to the design and simulation of MEMS based silicon micro-needles. It presents the analysis for the out-of-plane microneedle that can be used for drug delivery and/or micro-needle that is capable of inserting or extracting fluid from the subcutaneous fat layer.

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.