

A NEW WAY TO MAKE PIEZO-ACTUATED MICRO DROPLET GENERATOR

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ABSTRACT

1. Introduction

Inhalation drug therapy (IDT) is becoming more and more popular as a fast facting ,non - invasive method with little side effect for drug delivery. According to the Food and Drug Administration's (FDA) guidance documents, when the diameter of droplet is about 5 μ m it is best for inhalation.[1] Current devices either use thermally actuated droplet ejection or the distribution of droplet size is not uniform.[2] Ink jet type droplet generator is good at droplet size distribution.[3]But the MEMS and silicon etching method is too expensive and droplet size is not small enough. Here a cheaper method for making ink jet type droplet generator is presented.

2. Device design and fabrication

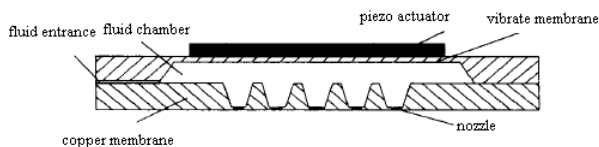


Figure 1. Device structure

As shown in the figure 1, the device consists of a sealed fluidic chamber with many holes on one side and a piezo actuator glued to the other. Actuating the piezo sends a pressure pulse towards the nozzles and results in droplet ejection. Obviously the device has three parts, piezo actuator, nozzle membrane made by copper and the fluid chamber structure.

Thanks to Dr. Meng's group who use the electric spark to etch about several hundred wide groove on the metal. So if a series of grooves are etched parallel on the surface of metal and do the same thing from perpendicular direction on the surface, then an array of needles can be got. This needles array can be used as mold to repeatable press membrane to get the arrays of nozzles. But the problem is the minimized holes size is about 50-100 μ m diameter. To get about 5-10 μ m diameter holes what is expected, it is possible to shrink the holes through electroplating. For electroplating convenient, copper is choose for nozzle

membrane. The depth of nozzle is about 350 μ m, another problem is if the nozzle membrane is too thin, during the separating of pressing procedure, the nozzle membrane may become deformed. So 500 μ m thickness copper sheet is used in pressing procedure which means the holes are not pressed through but depend on the following electroplating.

Both cathode and anode are copper; copper sulfate is main electrolyte for electroplating. Anode reaction is etching copper and cathode is electroplating copper. These two reactions are reversible. Glue some polymer on the holes side to protect the holes, etch the other side until the holes get through, then plating to shrink the holes' size, if control reaction time and current, adjust etching or plating it properly. Around 5 μ m diameter nozzles array can be achieved.

The piezo piece here is 2cm diameter and 100 μ m thickness. A circuit has been made to supply voltage. The circuit can provide from 0-48V, 5000-1000000HZ frequency sinusoidal signal.

The chamber structure can be made by MEMS. The vibrable membrane is for insulating the piezo actuator from the fluid, and not too rigid or too soft to get good vibration condition. Plastic membrane is good for the work. Stick plastic membrane on silicon wafer, run through MEMS procedure, fabricate the chamber and fluid entrance structure by SU-8. After tear off it from the wafer and glue three parts together, the device is completed.

3 Further work

As requirement in the Food and Drug Administration's (FDA) guidance documents, the distribution of droplets which is sprayed on certain distance plate can be observed. The voltage and frequency of the signal can be adjusted to get the best result.

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