정전기력 잉크젯 시스템을 위한 Non-MEMS 기반의 정전기력 노즐 설계

Fabrication of Non-MEMS based Electrostatic Nozzle Design For Electrostatic Inkjet System

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1. Introduction

The paper presents the fabrication of microsacle nozzle and patterning by means of electrostatic field induced using drop-on-demand inkjet printing scheme. In the electrostatic inkjet system for printed electronics, drop generation depends upon the electrostatic pull of the electrical field generated on the drop by electrodes. The focus of the research is to analysis and study the fabrication of Non-MEMS based nozzle head. The key focus area of this research is to the study the drop shape on the meniscus of the designed nozzle head and to find the precise placement of the electrodes. Typically by using the micron scale nozzle, it's possible to eject droplets and show feasibility to form patterns ranging from micro scale to nano scale on large area substrates at high speed. Most commercial available inkjet system uses piezoelectric, thermal or aerosol based system to generate ink droplets for fabricating printed displays and printed-circuit-boards [1]. Inkjet printing has advantage of producing printed electronics cheaply over a large area of substrate than photolithography and conventional MEMS based manufacturing technology. Beside this advantage most of the power being generated by thermal and piezoelectric inkjet technology is utilize for intermediate actuator rather than the mechanism responsible for generating inkjet droplets. To overcome the problem associated with piezoelectric and thermal inkjet system electrostatic inkjet printing has received immense attention in the past few years. But, now the focus of research is changing towards the electrostatic approach because the mechanical movement constrain limits the system for small nozzle size which in turn affect the drop size. The electrostatics systems reduce the mechanical efforts and make system more precise even at higher frequencies and its possible to get small and focus drops with even smaller nozzle size [3].

In this paper a novel non-MEMs based sub-micron electrostatic inkjet head design is being introduced and manufactured through in-house fabrication facility. The Printed Circuit Board (PCB) has been used to design and fabricate the nozzle head. This paper presents the fabrication of nanoscale nozzle and patterning by means of electrostatic field induced drop-on-demand inkjet printing system, to overcome the constraints and problem of conventional thermal and piezoelectric print heads described above.

In classical EHDA, the liquid flows through a nozzle under a voltage applied between the nozzle and an electrode held beneath it, producing a jet, which subsequently disintegrates into droplets, and this phenomenon obeys a well established rule [2]. Different ways of fabrication and design of nozzle head are under discussion and study. Here, a very novel approach for fabrication and design of nozzle is under discussion.

2. Design And Fabrication of PCB Based Nozzle Head

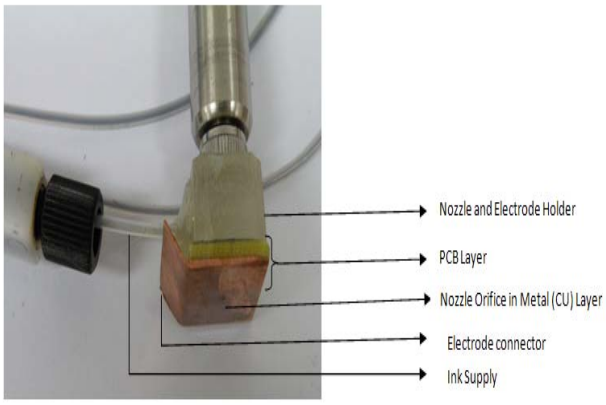


Fig. 1 PCB based Nozzle Head

The fabrication process is based on different processes narrated below; For the metallic composition of the PCB thin layer of metallic layer of copper (CU) is less than 100 μm is taken and baked with the insulator sheet having Teflon layer sheet between it for 150^{o} C for 10 minutes. After the connection between the insulating and metallic layer a drill has been done between them to make space for the electrode, ink channel and nozzle orifice as shown in the figure 2.

(a) (b)

Fig. 2 Drilling of hole in the PCB nozzle (a) showing the top view through insulator (b) showing image through metallic layer (bottom side of PCB nozzle for the orifice design)

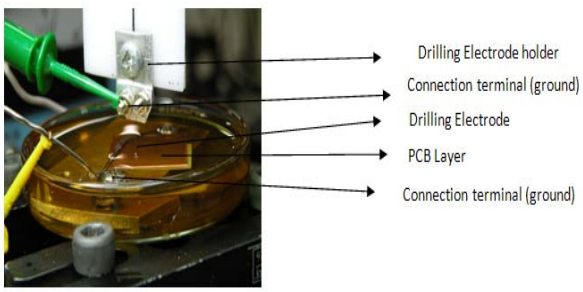


Fig. 3 EDM work on CU layer

After drilling the hole in the insulated layer, the Electrical Discharge Machine (EDM) is used to drill the hole in the metallic layer for the fabrication of specified nozzle hole as shown in the figure 3. By using EDM we are able to develop less than 50μm outer diameter nozzle orifice. And the results are also shown in the figure 4 below:

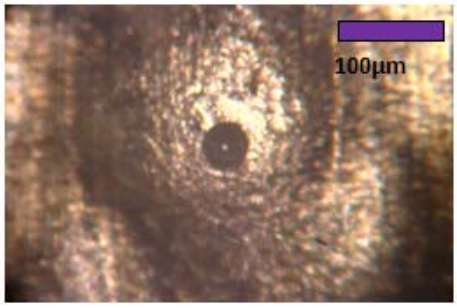
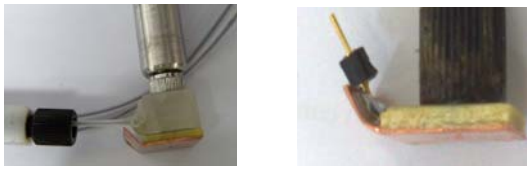


Fig. 4 Fabricated nozzle orifice through EDM

For holding and ink supply system in nozzle holder the alkenes material is used as shown in the figure 5. The holding and ink supply is glued with the ink orifice based in PCB structure. And for high power supply the power transfer connection is also provided to the nozzle head as shown in the figure 5.



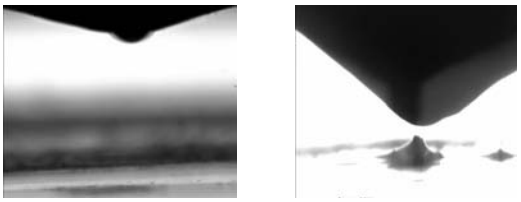
(a) (b)

Fig. 5 Holding and ink flow mechanism and connection of the power supply to nozzle

3. Results:

To check the behavior of the nozzle, the nozzle is tested under different conditions and the behavior of the nozzle is analyzed. In this case, the nozzle head is kept under equilibrium conditions (without applying any pressure or voltage) for half an hour to check the meniscus of the drop [4]. For this purpose, 44μm outer diameter nozzle is used and the response is shown in the figure 6. This information is taken using the high resolution camera of ITI drop watcher.

Fig. 6 Initial meniscus after leaving the nozzle for 30 minutes.



(a) (b)

Fig. 7 show the response of the nozzle after applying the pot ential on the nozzle head. Figure (a) shows the initial resp onse of the meniscus after applying the voltage and figure (b) shows the response of the nozzle after time t.

4. Conclusion

In this paper, a very novel and simple approach for fabrication and design of nozzle is studied and analyzed. The idea is to fabricate and design simple nozzle head for the development of printed electronics. This was introductory level research on the given topic and for the more advancement of this research; different parameters should be studied under industry conditions by varying other parameters. The study shows that PCB based nozzle head is has many benefits over the conventional approach.

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