Printed Electronics 를 위한 잉크젯 공정에 관한 연구

Study of Inkjet Printing Process for Printed Electronics

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1. Introduction
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Mostly commercial available systems for the development of printing electronics (PE) are piezoelectric and thermal based. 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 it is possible to get small and focus drops with even smaller nozzle size. And by using DOD techniques, the system can be made more energetic. Inkjet printers are being used for numerous commercial applications. Earlier, Inkjet printing is used to print on papers, only but now printed electronics field is also one of the emerging areas. Micro drop Ink jet technologies are receiving increased interest in applications outside of conventional printing and marking. Because of this, different techniques and procedures are necessary to evaluate. Recently, much attention has been spent on drop on demand (DOD) printing due to its large commercial accessibility. In different types of printing different material and printing mechanism different arrangements and strategies are needed [5]. In this research, the idea is to explain the fabrication of hybrid LED using DOD electrostatic inkjet printing mechanism.

Ink jet printing offers many of the capabilities of the techniques described above, including the ability to print narrow lines and surface-bound gradients, with the additional characteristic that it is programmable [1]. To be used for PE manufacturing, the liquid droplets must contain nano-particle material. The ink is forced through a small orifice with the help of electrostatic forces. Thus, the liquid droplets impact the substrate. This article intends to provide a general review of the techniques for patterning. The intend is not to cover in depth all the technical details of the patterning techniques or to describe their trend and sophisticated variants as it is also impossible to exhaust all types of materials that an inkjets printer can use [2].

2. Inkjet Printing System setup

The overall setup is shown in the Fig.1 and physical experiment model is based on pin to pin (P2pin) configuration [5].

Fig. 1 Experiment setup

3. Hybrid Printed Electronics

The idea is to print electrical lines on the substrate containing sufficient amount of the current and then embedding the IC chip in such a way that we can use the hybrid structure of electronics. For experimental purpose, here we have use the LED IC and connected with printed electronics for the experimental purpose. The desired printed line is achieved by using three pass on each line.

For performing the experiment we have to control different parameters like voltage and its offset, frequency, (moving) speed of substrate, type of substrate, nozzle-size and duty cycle etc. The different optimal voltages for experiment have been chosen from doing multiple experiments on the same ink on designed setup of DOD PE Inkjet model. The size of the cone is dependent on different parameters involving viscosity of ink, applied voltage, nozzle diameter and applied pressure [4] and also noted point was the accuracy capability when fluid is being jetted from system [3]. The detail description of the model is given below.

3.1 Electrostatic parameters

Electrostatic parameter includes voltages and its offset, frequency and duty cycles. In this experiment the voltage is maintained around 3KV with frequency of 1 KHz and duty cycle of 50%. Duty cycle is also important factor of the electrostatic because otherwise system may start spraying [6].

3.2 Substrate parameters

PET substrate was used in this experiment without adding any adhesive components. The nozzle head was stationary and substrate was moving with the speed of 3mm/sec.

3.3 Nozzle and Ink

Hole type capillary nozzle of internal diameter 110 μm is used in this experiment. For electrostatic experiment purpose nozzle is given positive charge, which in turn make the ink flowing in the nozzle positive potential. The ink consists of nano-particles, containing silver as pigments with very low viscosity and higher percentage of pigments. The ink is injected in the nozzle by using a syringe pin in such a way that the gap due to the drop of the ink could be filled. The flow rate in this experiment is maintained around 4ul/h.

3.4 Curing

For curing purpose, the fabricated lines were put under heater for 15 mins under temperature of 150^{o}C.

4 Results

By using above parameters we are able to design 1x1 and 2x2 matrix shape LED structure. Both, experiment were on the digital AC waveform to replicate drop on demand stagey.

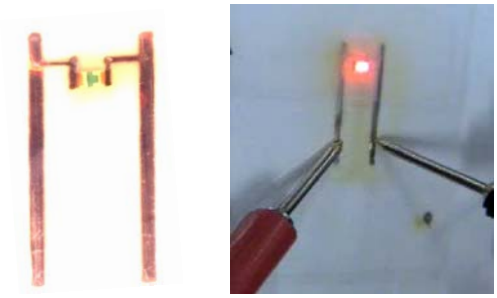

Fig. 2 Shows the LED model (1x1) hybrid printed Led

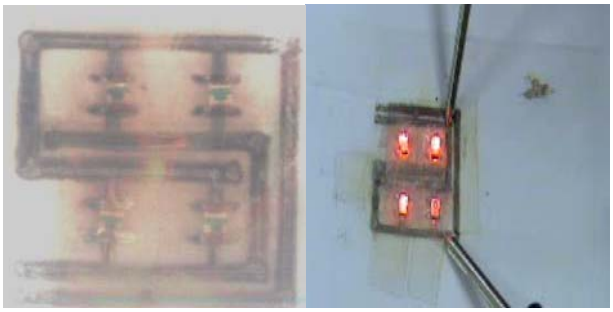

Fig . 3 shows the multiple (2x2).
hybird printed LED model and its results.

5. Conclusions

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 is very important in designing, fabrication and manufacturing for different organic electronics components. We are currently building our physical electrostatic model of inkjet printing to obtain better control of the drop size and line. Inductor model using electrostatic Inkjet system is also shown in the Fig 4.

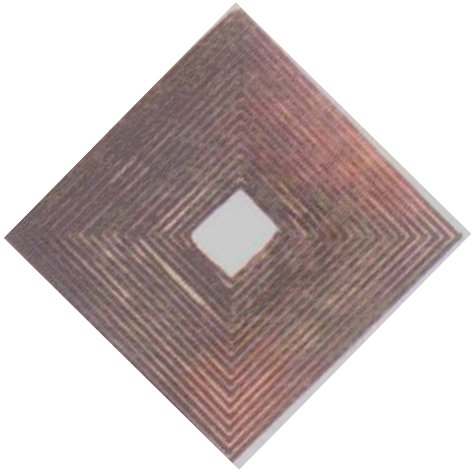

Fig.4 Printed Inductor model

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