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Electronic Inkjet Technology and Its Applications

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Abstract: An update on the recent developments in the inkjet printing technology along with its applications are provided in this progress report, including biological thin film transistors, conductive structures, the light-emitting diodes, memory modules, solar cells, various biological / pharmaceutical tasks and the sensors. Different classes of materials and the varieties of devices are investigated in turn and a point of view is given on the type of the progress made. In this paper, a description of a printer that employs the electrostatic and synchronous ink jet process of printing for word processing device production is provided. This provides an explanation of the printing phase of the ink jet framework as well as brief explanations of the printer components. Printer performance targets are discussed, addressing some of the major design issues that have been experienced during production.

Keywords: Inkjet technology, applications, LEDs, printers, electronics.

INTRODUCTION

Inkjet printing [1] is known as a method that is used in the liquid phase materials to retain the deposition. Such compounds or inks basically consist of a pigment that has been dissolved or otherwise extracted in a solvent. The method involves basically ejecting a fixed quantity of the ink from a nozzle and into a chamber through a rapid and quasi-adiabatic [2] reduction of the volume of the chamber by piezoelectric [3] action. Fig 1 shows the drop drying after printing

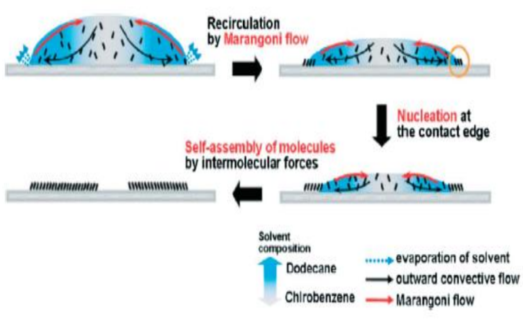

Fig. 1: Illustration of drop drying after inkjet printing

As a response to facilitation of an external voltage supply, contraction of a chamber full of liquid occurs. This abrupt reduction sets up a forceful shock-wave in the liquid that causes a drop of liquid to be ejected from the nozzle. The method has been studied at some length and some of the recent review articles are referred to the reader.

The ejected drop is made to fall under the gravity and the action of the air resistance until it impacts the substratum, spreads under the effect of the momentum i.e. acquired in motion, moreover, surface tension helps in the flow along the surface. Figure 1 illustrates the drop that then dries via a solvent evaporation. Fig 2 shows the various ink drops after printing.

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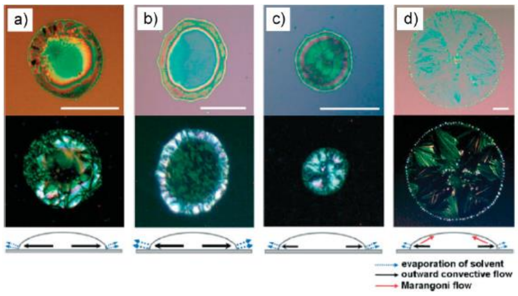

Fig. 2: Microscopic images of inkjet droplets of (a) Chlorobenzene, (b) hexane, (c) o-dichlorobenzene, (d) dodecane

Precise positioning of the active material inside the region made of gate electrode prevents the large leakage currents and the crosstalk's between TFT pixels and preserves ink. Lim et al. [4] has recently demonstrated the importance of solvent mixtures in drying droplet so as to balance the connective as well as Marangoni [5] flows, thus controlling dried droplet based morphology as depicted in Figure 2.

Singh et al. [6] has demonstrated vivid inkjet printer OLEDs [7] that are based on a IR-based luminescent macromolecules that are anchored on a polyhedral oligomeric silsesquioxane or POSS molecular scaffolding for use as a phosphorescent dye in a polymer ink that contains a hole carrying polymer as well as poly (9-vinylcarbazole) (PVK) and an electron carrying polymer, 2-4-biphenyl-5-4-tertbutyl-phenyl-1, 3, 4-oxadiazole (PBD).

Interferometry [8] measurements of the white light have revealed high interface roughness for the printed layers, underlining the role of sufficient ink chemistry in deciding overall system brightness given quenching from the rough cathode contacts.

As shown in Figure 3, the authors have achieved a peak luminance of 10,000 cd m2 by improving print morphology as well as the dye chemistry.

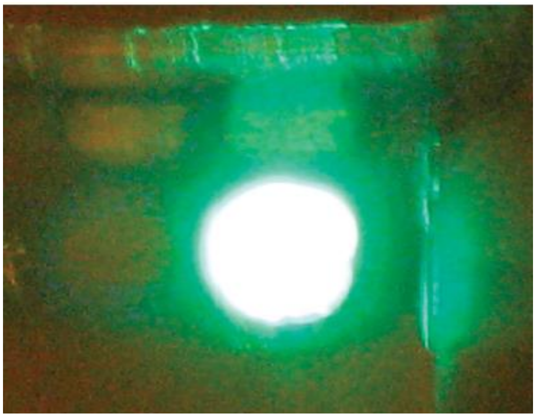

Fig. 3: Photograph of a 10000 cd per meter square OLED

INK JET PRINTING PROCESS

Sweet [9] invented a method of shaping in the early 1960's, thus charging and then electrostatically deflecting a very high-speed stream of small drops of ink in the early 1960s in order to create high-frequency traces of oscillography in a signal recording and direct-writing system. That drop is charged electro-statically, which is a function of the instantaneous value that relies on the registered electrical input signals.

The deflection of the drop from its known path occurs by a quantity depending on the magnitude the charge and the direction that is a feature dependent on the polarity of charge. When deflected drops are deposited on a strip of a moving chart paper, the traces of input signal are created.

The Sweet's technique was extended by Lewis and Brown [10] so as to allow the character printing. Script images are housed in a script generator in the binary form. A character generator is addressed by an encoded signal so as to select desired signals. Finally, the necessary drop charging signals generate the binary image of that particular character. This in turn deflects drops to various matrix positions of the suitable character.

This general approach is used in our printer despite of the fact that numerous problems had to be overcome in order to apply it in a robust system intended for a high quality based commercial use.

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The printing process works essentially as presented in figure 4. A jet is formed by forcing down a conductive ink that is placed under pressure down into a small nozzle. Normally, the jet is broken down into a stream of drops. These drops are of a quasi-random size as well as spacing, but still, the formation of these drops can be controlled by vibration of the ink at a fixed ultrasonic intensity inside the nozzle cavity.

At a specific distance from the nozzle, the pressure waves force the jet to break up at a very well-defined distance from nozzle into a stream of drops of a uniform size and a uniform spacing.

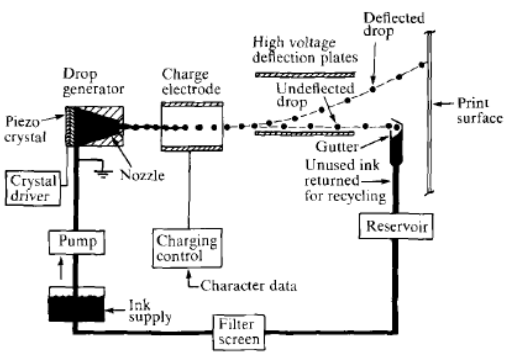

Fig. 4: Process of ink jet printing through electrostatic deflection

Ink filtering is the key to printer's efficiency. Since the orifice of the ink nozzle is of 0.033 mm (1.3 miles) size in terms of the diameter, particles in ink of this size or greater size must not touch the nozzle. It is also necessary to control the particles that are small enough to enter into the nozzle and cause the short-term variations in the jet velocity that affects the accuracy named as drop placement.

An ink flow route diagram is shown in the Fig. 5. In order to pump out from a replaceable container, a filter A is used to draw the ink out. The ink is made to flow through another filter B, before it gets entered into the valve generator. The ink in the drop generator is made to flow through a final filter (C) before it reaches the nozzle.

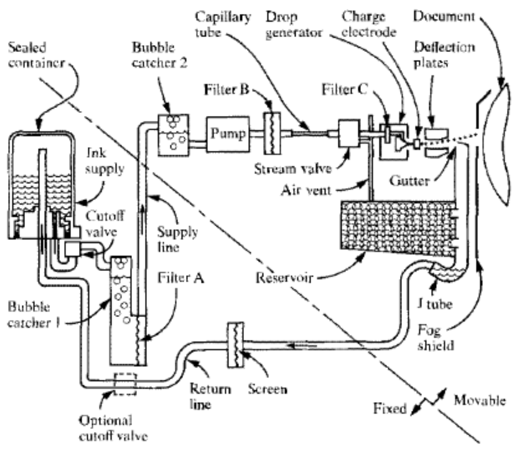

Fig. 5: System for ink circulation

The ink is made to leave from the nozzle as the jet afterwards breaks up into drops. The un-deflected drops are collected in the gutter as mentioned earlier. Accumulation of the ink occurs in the gutter in a slump and as a result is drawn back through a filter by the pumps into the ink jar.

CONCLUSIONS

Deposition methods of the materials for OLEDs, OTFTs and the solar cells etc. currently include the use of either vacuum deposition or the spin-coating or the approaches. In some cases inkjet printing has been used to deposit the multiple layers of the product structure.

In comparison to inkjet printing, conventional deposition methods involve a lot of waste material, which result in relatively uniform deposition of profiles over the substrate. In contrast to this, inkjet printing is an anisotropic or localized process of deposition that easily lends itself to a patterned writing and/or mask less processing.

Inkjet printing is an appealing, material-conserving option for multiple patterning based applications, given the obvious expense of lithography steps in the industrial manufacturing and the imperative to limit the number and amount of complexity of such steps. The inkjet printing that is anisotropic in nature howsoever also leads to problems that are not encountered in the planar processing that is currently used in industry.

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