Effects of Substrate and Surface Energy on Ink-jet Printing

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Abstract

The fundamental parameters controlling ink-jet printing liquids are the viscosity and surface energy. The wetting contact angle determines the spread of a liquid drop on the surface and depends on the relative surface energy. The characteristics of silver ink-jet printing were studied with control of surface energy and head temperature. Polyethylene terephthalate(PET) film and Si-wafer(p type) were used as substrates and atmospheric plasma was treated to control the surface energy. With silver ink, the hydrophilic surface treatment could reduce the radius of droplets due to the hydrophobic nature of silver ink.

1. Introduction

In display industry, one of main issues is how to make the product easy and cheap. As process-wise, photo-lithography is one of expensive process and ink-jet printing may be one of an alternative manufacturing method. The initial impetuses to create ink-jet printing technology for displays were the deposition of polymer light-emitting diodes, for which conventional photolithography is difficult because of material sensitivity, and the reduction of the fabrication cost of color filters for liquid crystal displays[1]. Initial booming of this technology was doomed to have the limitation on resolution and reproducibility. Nevertheless, this technology has many benefits such as its low cost, low-temperature process, direct writing, solution processing, and rapid prototyping, especially on for fabrication of polymer flexible electronic circuits. The fundamental parameters of the formed pattern with ink-jetting are the viscosity of ink and surface energy of ink-surface. The wetting contact angle determines the spread of a liquid drop on the surface and depends on the relative surface energy[2-3]. In this work, commercially available silver ink was used to exploit the surface-ink interaction by the surface treatment.

2. Experimental

The Ink-jet printer was a drop-on-demand type (UJ200/UniJet) and nozzle orifice diameter was 50μm (MJ-AT-01/MicroFab). The silver ink with a metal content of 15 wt.% (TEC-IJ-010/InkTec) was printed on polyethylene terephthalate(PET) and Si wafer. PET and Si wafer substrates were washed with IPA (isopropyl alcohol) before printing and further treated with plasma in order to control the surface energy of substrate. Printed patterns were sintered at 130℃ for 10min under air atmosphere. The sintered pattern structures ware observed by surface profiler.

3. Results and discussion

Surface energy of substrates was controlled with atmosphere plasma treatment. The water contact angle provided the information regarding wettability and surface energy of film. Figure 1 shows the actual radius of droplet and width of line of silver ink as a function of contact angle of DI water on PET substrate with given finite volume of silver ink. The result indicates the linear relationship in radius and line width of silver with contact angle due to the hydrophobic nature of the silver ink. Figure 2 shows the surface profile of droplet on Si-wafer. It has been shown that different size of droplet with contact angle and can be understood as surface-wettability. Along with the decrease of contact angles or hydrophilic nature, the surface energy of substrate increased. Since silver ink having hydrophobic character could not be wetted easily on the hydrophilic treated

substrate, it will result in smaller droplet size.

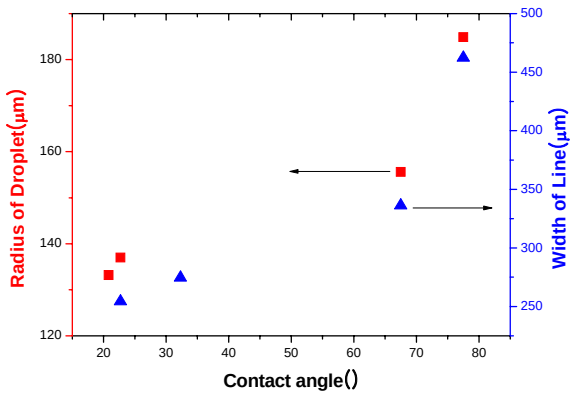

Figure 1. Radius & Width vs. contact angle on PET film.

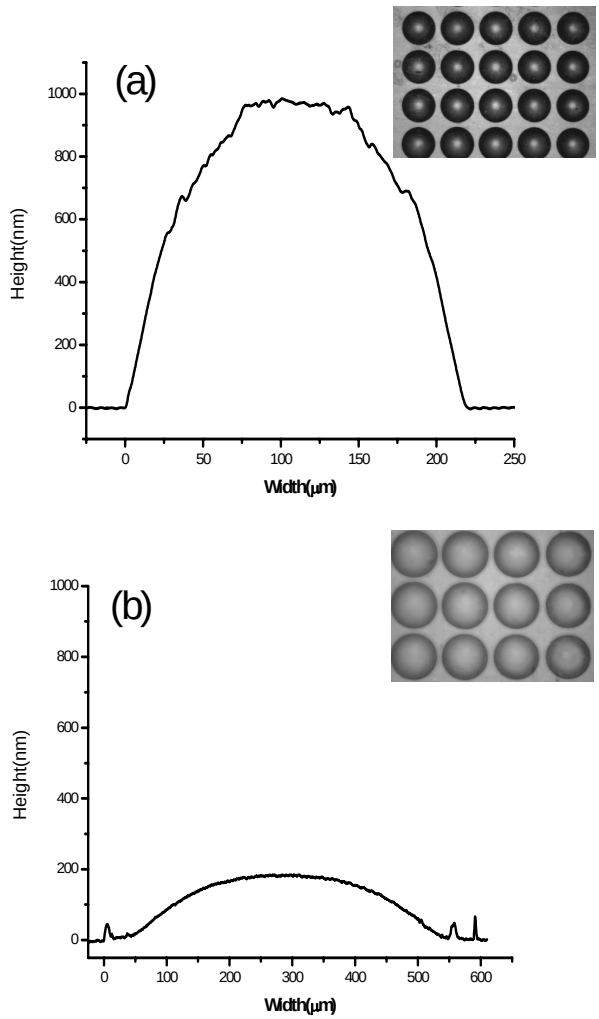

Figure 2. Surface profile of droplet on Si-wafer. (a)hydrophilic, (b)hydrophobic treatment

4. Summary

The objective of this work is study the relationship between the silver cluster solution and different surface energy. The developed surface control method can be used for controlling droplet size in ink-jet printing. Suitable jetting condition and substrate treatment will give an advantage to micro fabrication pattern in ink-jet printing.

Acknowledgement

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5. References

1. R. A. Street, W. S. Wong, S. E. Ready, M. L. Chabinyc, A. C. Arias, S. Limb, A. Salleo and R. Lujan, *Materials Today*, **9**, 32(2006).
2. Z. Liu, Y. Su, and K. Varahramyan, *Thin Solid Films*, **478**, 275(2005).
3. S. H. Lee, K. Y. Shin, J. Y. Hwang, K. T. Kang and H. S. Kang, *J. of Micromech. Microeng.*, **18**, 7(2008).