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BSI Standards Publication

Printed electronics

Part 302-6: Equipment — Inkjet — First drop measurement

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PRINTED ELECTRONICS –

Part 302-6: Equipment – Inkjet – First drop measurement

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INTRODUCTION

Drop-on-demand inkjet printing has been used as a manufacturing tool for printed electronics. The use of inkjet has many advantages since an exact amount of droplets can be deposited on target locations without wasting excessive amount of materials. To position the inkjet head on the printing location, jetting from the inkjet head should be paused for a while. As a result, it has been well known that the initial first few drops, after the non-jetting pause time, can be different from that of the steady state jetting. The abnormal behaviours of the first few drops can cause serious printing quality problems. Also, it could produce poor yield when used in manufacturing process. So, the proper evaluation of first-drop failures has been important steps for inkjet process development.

Moreover, substrates can be unloaded and loaded for printing, especially in printed electronics applications. By using a fiducial camera to view the substrate, the printing target position in the substrate is identified via alignment marks on substrates. Also, the substrate should be aligned with respect to motion stage axes prior to printing. It can take considerable time and the jetting should not occur during the preparation for printing. Due to the non-jetting period, ink on the nozzle surface can dry, and consequently the jetting behaviours of the first few drops are likely to differ from those of steady-state jetting. If the abnormal jetting behaviour is significant, printing quality can be affected accordingly. As a result, a proper measurement method should be developed to evaluate the jetting failure.

The main cause of the first drop behaviour including low jetting speed and non-jetting status can be from the ink drying on nozzle substrates. However, apart from the ink solidification on substrate, it can be affected by jetting frequency. The piezo type inkjet head uses pressure waves generated inside of the head. The first drop is not affected by the residual pressure waves from the previous drops. However, from the second drops, the jetting can be affected by residual pressure waves from the previous jetting. Also, pressure wave amplification is different according to jet frequency due to residual pressure. Thus, the first drop behaviour might be affected. This document provides the measurement and analysis method for first drop dissimilarity but does not provide the method to decide the cause of the non-similarity of first drops. Nonetheless, by engineering judgement, the causes of first drop dissimilarity can easily be determined.

In order to measure inkjet behaviour, the methods using drop visualization systems based on a light emitting diode (LED) have been standardized. The methods are useful because real-time monitoring is possible by using a charge-coupled device (CCD) camera. However, the method has difficulty and limitations in measuring the transient jet behaviour of the first few drops because it uses a low-frame rate (~30 frame/s) CCD camera. Nevertheless, the conventional hardware for drop visualization system can be used for first drop measurement by modifying the measurement methods.

In this document, the measurement method and guidelines will be presented including the method using a CCD camera illuminated by pulsed light. Other methods are also presented including the methods based on high speed camera as well as printing system. Most printing systems are capable of inspecting printed dots right after printing. Printed patterns can be effectively used for evaluation of first few drops in relations to various parameters.

On the other hand, the price of high speed camera is becoming cheaper and the performance is improving. The hardware requirement and synchronization method is relative simple when the high speed camera is used for measurement. In addition, the method using high speed camera does not require an expensive printing system and first drop effects can be effectively analysed.

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Each method has merits and limitations and this document does not recommend specific methods.

The evaluated first drop behaviour can be used for ink development to improve jetting quality. Also, it can be used for process development such as pre-spitting (or pre-jetting) method and head control method (for example, meniscus excitation method).

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