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General requirements for the inkjet printing technology of new display devices

新型显示器件喷墨打印技术通用要求

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Table of Contents

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1 Scope

This document specifies the process flow, process guarantee conditions, raw and auxiliary materials, inspection and other requirements corresponding to the inkjet printing technology of new display devices.

This document is applicable to the processing and quality inspection corresponding to the inkjet printing technology of new display devices.

2 Normative references

The following referenced documents are indispensable for the application of this document. For dated references, only the edition cited applies. For undated references, the latest edition of the referenced document (including any amendments) applies.

ISO 14644 (all parts), *Cleanrooms and associated controlled environments*

3 Terms and definitions

For the purposes of this document, the terms and definitions apply to this document.

3.1 new display device

It refers to newly developed display devices relative to traditional LCD devices, including OLED, QLED, Micro-LED and other display units.

3.2 inkjet printing

The process in which the ink is driven by the nozzle to form ink droplets under the action of the software system and control board, and then sprayed onto the substrate to form a pattern structure.

3.3 substrate

A carrier substrate made of glass, plastic or other materials.

3.4 substrate calibration

Correct the error of the substrate posture relative to the printing positioning after the

substrate is loaded onto the printing platform.

3.5 waveform adjustment

It refers to adjusting the voltage, pulse width and other parameters of the nozzle to obtain stable injection parameters such as volume, speed and angle of ink droplets.

3.6 drop watching

Use an industrial vision system to observe and record images and data of ink droplets.

3.7 patterning settings

Set the parameters and printing requirements of the printing pattern to prepare for pixel pit filling or film preparation.

3.8 pixel resolution

The minimum distance that each pixel of an industrial vision camera can resolve within the imaging field of view.

3.9 offset setting

It refers to the compensation setting of the printing landing point in the X and Y directions, so that the actual landing point coordinates coincide with the theoretical landing point coordinates.

3.10 mark

Fiducial pattern for optical positioning during inkjet printing.

4 Process flow

4.1 Overview

The process flow of inkjet printing technology includes substrate calibration, waveform adjustment, drop watching, patterning settings, trial printing, nozzle screening and offset setting, substrate printing, and post-printing inspection. The process flow diagram of inkjet printing technology is shown in Figure 1.

viscosity) should meet the jetting viscosity requirements of the printhead.

4.3.2 The steps for waveform adjustment are as follows:

a) Adjust the negative pressure of the ink path so that after the nozzle squeezes the ink, the ink droplets hang on the surface of the nozzle without dripping or flowing back;

b) Switch the ink circuit to semi-automatic mode. Wipe the nozzle surface until it is clean. Switch back to automatic mode;

c) Set the waveform according to the standard waveform parameters and observe the injection status;

d) Adjust the voltage amplitude, voltage duration, pulse number and other parameters to limit ink drop tailing, satellite drops, etc. until the ink drop is spherical and the speed meets the requirements.

4.4 Drop watching

4.4.1 It is used to determine the volume, speed and angle of ink droplets, measure the jetting stability of nozzles, and remove unqualified nozzles to improve printing quality.

4.4.2 The steps for drop watching are as follows:

a) Move the nozzle to be observed to the drop watching position;

b) Control the nozzle to spray at a specific frequency. Synchronously trigger the industrial visual camera of the ink drop observation system with a pixel resolution of ≤0.5 μm/pixel to collect ink drop images;

c) Process the ink droplet image and calculate the volume, velocity and angle of the ink droplet ejected by the nozzle;

d) Move to the next nozzle observation position. Repeat steps b) and c) in 4.4.2 of this document until all nozzles are inspected;

e) Set the upper and lower limits of the volume, velocity and angle of qualified ink drops. Remove unqualified nozzles.

4.5 Patterning settings

4.5.1 Before patterning, the substrate calibration accuracy should satisfy the substrate angle deviation ≤ 0.005°.

4.5.2 The patterning setting steps are as follows:

a) Import the nozzle status, including the abnormal nozzle number, the volume value of the normal nozzle, the average drop point error of each nozzle and the nozzle positioning coordinates;

b) Set the substrate pattern parameters, including pattern point spacing and number of rows and columns, pattern array spacing and number of rows and columns, pattern volume value, printable range, and pattern point positioning coordinates;

c) Construct the position constraint of the printing planning model based on the positional relationship between the nozzle and the pattern. The volume of the printed pattern is used as the result constraint. The number of prints is used as the optimization target;

d) Solve the model to obtain the optimal printing path for the current state.

4.6 Trail printing

The steps for trial printing are as follows:

a) According to the requirements of nozzle screening and drop point deviation analysis, select specific nozzles or all nozzles. Generate dot matrix printing plan through patterning settings;

b) Place a substrate with a hydrophobic film on a stage;

c) Conduct vacuum adsorption to fix the substrate;

d) Define the printing starting point;

e) Call the generated dot matrix printing plan to print.

4.7 Nozzle screening and offset setting

The steps for nozzle screening and offset setting are as follows:

a) The industrial vision camera takes pictures of the test printed dots;

b) The software calculates and compares the actual coordinates of each ink droplet landing point with the standard coordinates to obtain the printing deviation value of the ink droplet landing point;

c) Calculate the average landing point deviation value of each nozzle hole according to the printing deviation value of the landing point;

d) By comparing the average drop point deviation value of each nozzle with the required value, the nozzles that can participate in printing are screened;

technical requirements shall be repaired and its technical status shall be re-verified after repair.

5.3.2.3 The process equipment shall be maintained in accordance with relevant regulations. After maintenance, the technical status shall be re-verified.

6 Requirements for raw materials and auxiliary materials

The raw materials and auxiliary materials used in the inkjet printing process of new display devices should be stored in accordance with relevant storage conditions. Use materials that have passed the inspection and are within the validity period. The requirements for raw materials and auxiliary materials that should be used are as follows:

a) Ink: 5 cps ~ 25 cps;

b) Substrate: substrate that has completed the pre-inkjet printing process.

7 Inspection

7.1 General

7.1.1 After each process step is completed, the results are inspected online according to the inspection requirements of each process.

7.1.2 Establish inspection specifications and conduct special inspections for key processes that directly affect the processing accuracy of inkjet printing technology for new display devices.

7.1.3 Establish final inspection specifications. Inspect the final processed inkjet printing display device structure according to the specifications. Eliminate defective products that do not meet the inspection standards.

7.2 Key process inspection

7.2.1 Substrate calibration inspection

7.2.1.1 Purpose of inspection

Check substrate calibration accuracy to calculate substrate angle and position and perform patterning calculations.

7.2.1.2 Inspection methods

The test steps for substrate calibration accuracy are as follows:

a) Testing: the industrial vision camera moves to the set multiple mark positions to identify the coordinates of the substrate mark;

b) Calculation: calculate the substrate error based on the coordinates of each mark;

c) Correction: when the substrate error is greater than the required value, adjust the correction amplitude according to the error value, and repeat steps a), b) and c) in 7.2.1.2 of this document until the substrate error value meets the inspection requirements.

7.2.1.3 Inspection requirements

Substrate angle deviation is ≤ 0.005°. Initial positioning is ≤ ± 0.5 mm. Positioning error in X and Y directions after correction is ≤ ± 10 μm

7.2.2 Drop watching inspection

7.2.2.1 Purpose of inspection

Check the spraying status and spraying stability of each nozzle to select the nozzles that can participate in printing and improve the printing quality.

7.2.2.2 Inspection methods

7.2.2.2.1 The test steps for ink drop volume accuracy are as follows:

a) Start the nozzle spraying. Use sensors such as industrial vision cameras with a pixel resolution of ≤0.5 μm/pixel to collect the ink droplet flight information;

b) Calculate the volume of a single or several ink droplets ejected from a single nozzle;

c) Sequentially collect the volume of ink droplets ejected from all or part of the nozzle holes of the nozzle;

d) Calculate the volume change of ink droplets ejected from all or part of the nozzles using statistical methods. Compare the volume change of ink droplets ejected from each nozzle with the required value. Select nozzles. Or use a precision balance as a testing tool to open the nozzles one by one. Measure the mass of individual or group droplets respectively, and then calculate the volume of ink droplets and volume deviation.

7.2.2.2.2 The test procedure for the ink droplet flight angle resolution is to use the calibration sphere as the observation object. First, the industrial vision camera of the ink drop watching system configured in the inkjet printer is calibrated for measurement accuracy. The motion control system drives the nozzle that ejects ink droplets to move

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