Study of Performance Improvement for Dye-Sublimation Printer

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Abstract

Dye sublimation printer print is possible to print on the high-resolution. But Dye sublimation printer receives high heat and pressure than Inkjet printer and Laser printer. Therefore, the surface paper is transformed, and there is a possibility of negatively affecting the print quality. Then, we verify the reason why the surface paper is transformed and Influence that transformation of surface paper gives print quality. (Key Words: Dye sublimation printer, Thermal print head, Micro heater, Numerical analysis, Positioning margi)

Introduction

Recently, due to widespread use of digital camera, the demand for high-resolution printer have grown. Because the dye sublimation printer is capable to print density tones, the output quality is as high as silver halide photographs.

Fig.1 shows the print principle of dye sublimation printer. The thermal head will apply pressure on ink ribbon against the special paper which has reception layer and it will apply heat by micro heater to diffuse ink to the paper. The dye sublimation paper receives high heat and pressure while printing compared with inkjet or laser printer. Therefore, it is possible to transform the surface profile of the dye sublimation paper and damage the print quality.

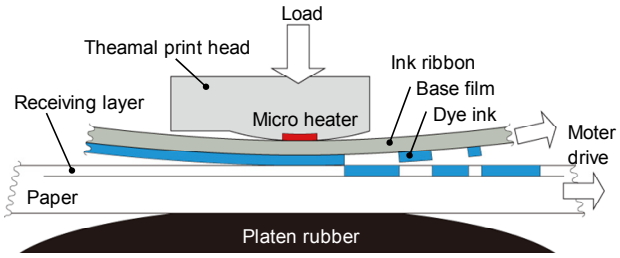

Figure1. Principle of dye sublimation printingl

In this study, aiming at further improvement of the print quality, we examined the influence of surface profile of the dye sublimation paper on the print quality. First of all, we observed the transformation of the printed surface of the dye sublimation paper with the contact microscope and examined the factor of transformation. Based on this study, we have improved the thermal head to prevent transformation of the dye sublimation paper. As a result, we were able to improve the print quality by having better glossiness and image clarity.

Experiment

We examined the relation between the print quality and the surface profile of dye sublimation paper. We made print samples by changing the relative position of thermal head and platen rubber of the printer and measured the profile and glossiness on the surface of dye sublimation paper. The position of platen rubber was changed in the range of -500μm to +500μm as shown in Fig.2.

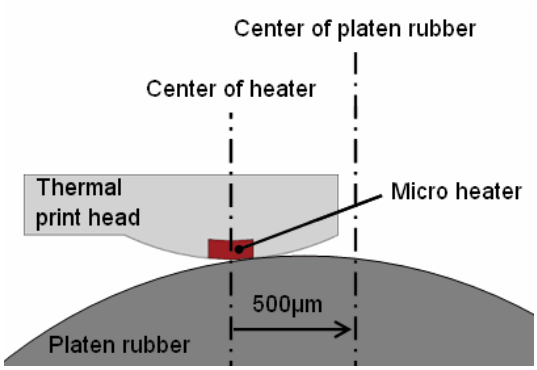

Figure2. Position of the thermal print head

The print was made every 100μm move of platen rubber.The load of a thermal head was kept 30N constant. The speed of the dye sublimation paper was 17.78mm/s(0.7ips). The voltage of the heater was 14V. The gap of thermal head position from the fixed position which is caused by friction was corrected based on preparative experiment.

Contact area observation

To understand the transformation of the dye sublimation paper surface, we observed the real contact area of dye sublimation paper. Contact microscope produced by Niigata University was used to observe real contact area.

Fig.3 shows the diagrammatic illustration of the optical system for this contact microscope.

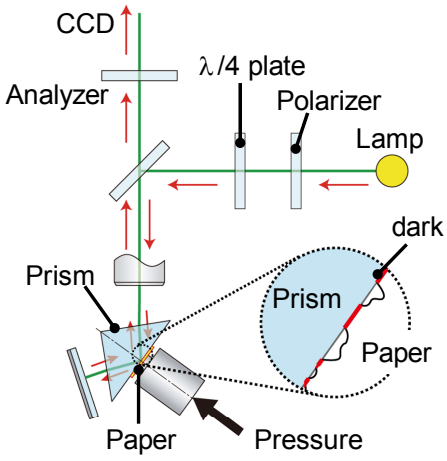

Figure3. Layout of the contact microscope

The light from light source becomes a linear polarization by passing the polarizing plate ([poraraiza]) and becomes an elliptic polarization through 1/4 wave plates. Because the phase of the light that reflects on the surface of the paper becomes discontinuous, only the polarized light that reflects in real contact area can be intercepted by adjusting with the poraraiza and the analyzer. Therefore, the real contact area looks black.

The real contact area of paper was measured by using this principle. The 5cm square aluminum was used for the plinth which press the paper against the prism. The pressing force of the plinth was adjusted to make contact pressure 1MPa.

The measurement was made at one point on the right side of printed surface. Afterwards, the ratio of a black area was measured from the obtained image as the real contact ratio. The real contact ratio of the dye sublimation paper before printing was 99.70%.

Measurement of glossiness

We measured the glossiness as one of the methods to evaluate print quality. The glossiness is the ratio of regular reflection on material surface. The glossiness was measured using gross checker IC-331 (made by HORIBA company) and 20 degree method (Fig.4).

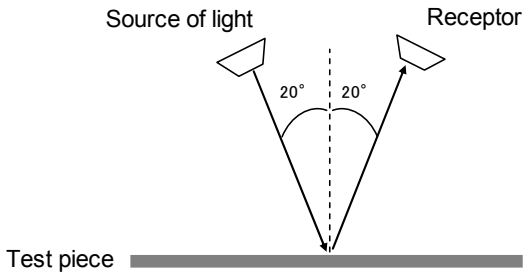

Figure4. Layout of deveice for gloss value

We measured glossiness on the print samples of experiment We measured three points on the right side of dye sublimation paper where we can get most steady prints and average of three was calculated as glossiness of printed surface.

Measurement of the image clarity

We also measured the image clarity as another method to evaluate print quality. The image clarity is a value of image clearness which reflects on the surface of material. We measured image clarity with the image clarity measuring instrument made by SUGA.

Fig.5 shows the principle of image clarity measurement. The light which passes 0.03±0.05mm slit becomes a parallel light and it is irradiated to the sample surface. The light that reflects from the sample surface is converged by the lens. The converged light is measured by the photoreceiver through an optical comb that moves right and left. If the image that reflects from the sample is not clear, the image width on optical comb extends.

When the image width is wider than the slit on comb, the amount of light to photoreceiver decreases. The calculation formula is shown below. (JIS K 7374:2007)

$$C(n) = \frac{M - m}{M + m} \times 100[\%]$$

C(n) : Image clarity at optical comb width n[mm]
M : The maximum amount of light at optical comb width n[mm]
m : Minimum amount of light at optical comb width n[mm]

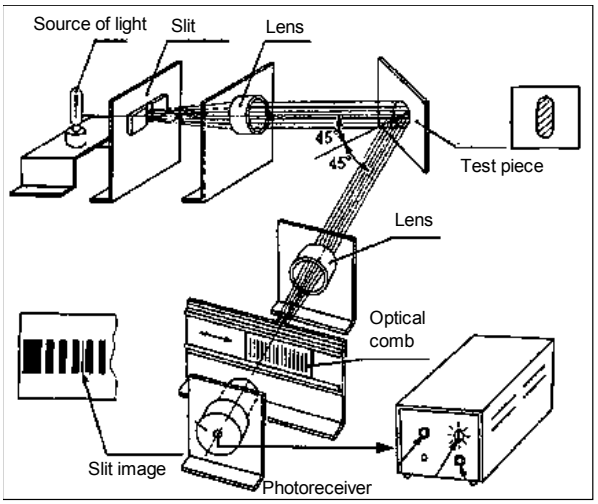

Figure5. Layout of device for image clariity

Result

The surface profile of dye sublimation paper

Fig.6 shows the image observed by the contact microscope. The surface profile of dye sublimation paper almost remain the same after printing when platen rubber is at negative position. However, it was confirmed that the surface profile became striated when platen rubber was at positive position.

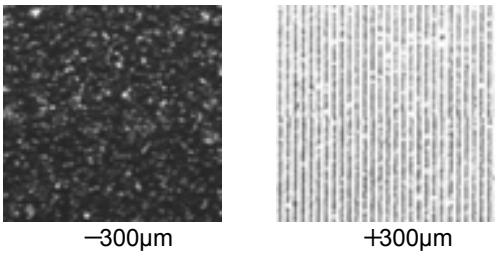

Figure6. The picture of the real constant area of papers

Real constant area ratio and glossiness

The relation between real contact area ratio and glossiness of dye sublimation paper is shown in Fig7.

Horizontal axis in the graph is a distance of platen rubber and the vertical axis is real contact area ratio and glossiness. It was confirmed that the glossiness decreases as platen rubber advances toward positive position. It seems that the glossiness decreases

because the surface profile of the dye sublimation paper is transformed.

The data shows that glossiness and real contact area ratio change responding to platen positon change is fairly corresponding. As a result, we could confirm that real contact area ratio and glossiness of the dye sublimation paper has strong relationship and therefore transformation of surface profile causes the decrease of print quality.

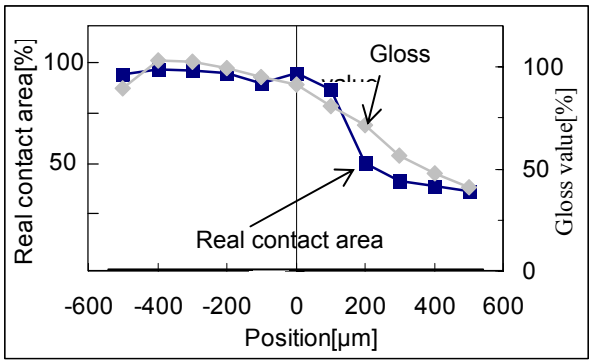

Figure7. The result of measurement

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Thermal head surface profile and surface profile transformation of dye sublimation paper

Fig.8 shows the thermal head surface image. The U-shaped electrode above the heater is higher than the heater and it forms step. The pitch of this electrode matches the striated trace on the paper and this fact provides that electrode is a cause of surface profile transformation of dye sublimation paper.

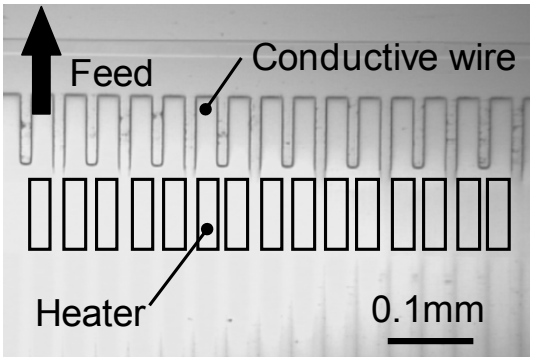

Figure8. Surface of themal print head

It is known that the contact pressure of a thermal head while printing is high in the center of the contact width. When the platen rubber position is in between 0μm to 500 μm, this electrode postion is in the center of high pressure area. Therefore, the dye sublimation paper will be strongly pressed by the electrode after heating. As a result, the shape of the electrode seems to be transferred on the surface of dye sublimation paper.

Then, in order to confirm the influence of electrode step on surface profile transformation, we have done an experiment with the thermal head eliminating electrode step. Fig.9 shows the paper surface profile .

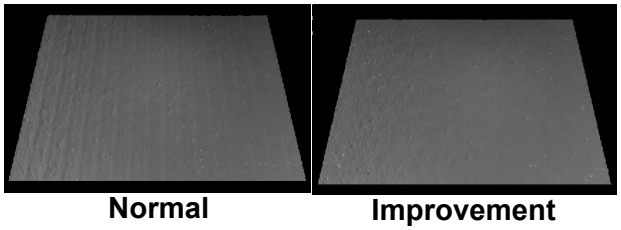

Figure9. The picture of papers shape

It was confirmed that the surface profile transformation did not occur with step free thermal head. In other words, we were able to improve the surface profile transformation of the paper by eliminating the electrode step on thermal head.

Next, we compared the print quality (glossiness and image clarity) of the dye sublimation printed by improved print head with other printing methods. Fig.10 shows the result of print quality comparison. Horizontal axis is glossiness and the vertical axis is image clarity. Measurement was done on two directions (horizontal and vertical). It was compared with inkjet, silver halide photography and electrophotography.

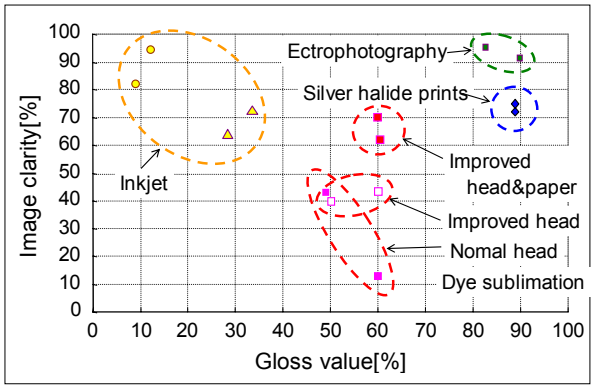

Figure10. The result of comparison

The glossiness and image clarity of silver halide photography are high as well as luster feeling. The glossiness of dye sublimation is higher than ink jet even before printhead improvement but the image clarity is lower. It is known that human's actual luster feeling is more closer to image clarity than glossiness. Because the image clarity is low, the luster feeling of dye sublimation print was felt low.

However, when the electrode step on printhead surface is eliminated, since the profile transformation of paper won't occur, the image clarity increased about 30% and therefore the luster feeling have also been improved. Moreover, as improvement on the paper side, if PP substrate is used for dye sublimation paper, glossiness increased about 10% and image clarity increases about 20% which made the dye sublimation print quality more close to silver halide photography.

Heat and surface profile transformation of paper

Next, we examined the influence of heat against surface profile transformation of dye sublimation paper. We compared the real contact area ratio between heated printhead and non-heated printhead under same printing conditon as 2.1. Fig.11 shows the result of experiment.

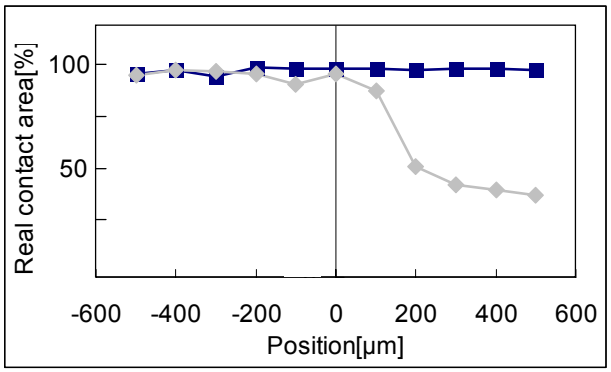

Figure11. The result of thermic effect

In case of using non-heated printhead, the real contact area ratio does not decrease even if the position of platen rubber is in the range of 0μm to 500μm which makes the pressure high. It shows that surface profile transformation of paper does not occur if it is printed wihtout heat. As a result, we understand that surface profile transformation of paper is greatly influenced by heat. It suggests that physical property of dye sublimation paper surface have changed by receiving heat. Therefore, in order to study the improvement of print quality in the future, it is important to understand the influence of heat to dye sublimation paper properly.

Conclusion

In this study, we aimed to improve the print quality and investigated the relation between print quality and surface profile transformation of dye sublimation paper. The following conclusions were obtained as a result.

1. The surface profile transformation of dye sublimation paper influences glossiness and image clarity.

2. The surface profile transformation of dye sublimation paper is caused by the shape of heater electrode which is pressed and transferred.

3. The surface profile transformation of the dye sublimation paper is highly influenced by heat.

The result of this study provided print quality improvement to our products.

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Author Biography

Hirotoshi Terao received his BS degree in materials engineering from Mining College at Akita University in1991 and .he received his Dr degree from Niigata University in 2006. He has worked at Alps Electric Co., Ltd. since 1991 and is currently a senior research scientist chief engineer in the R&D department. His interests are in research and development of thermal transfer technology and thermal print head. He received a technical award from The Society of the Electro photography of Japan in 1996 & 2010.