Development of True Edge H Series Printhead

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Abstract

Thermal printing is the main technology of ID card printer solution. The advantage of thermal method is to print photo like image on the plastic card instantly. And it enables on demand printing requirement. There are three market requirements to printhead to expand ID card printer application. The first one is the adjustment free feature. The second one is the fast heat response feature. The third one is the high scratch resistance feature. Kyocera has developed the new ID card printer printhead named H series. This H series has flatter ceramic surface curvature with thinner glaze. As a result, it realizes easy adjustment, high scratch durability and high speed printing capability.

Introduction

One example of ID card printer applications is Driver's license printer. Driver's license has personal photograph on the ID card and instant issuance is required. Advantage of the thermal method is to print high quality photograph with a special media such as Dye Diffusion Thermal Transfer (D2T2) ribbon. It also enables on demand printing instantly. True edge printhead also has a flat media pass capability. It enables printing on stiff media like plastic card. Those are the features of true edge printhead adopted in ID card printers like Driver's license printer.

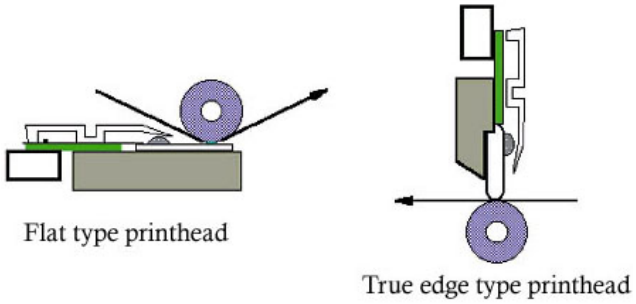

Figure 1. Type of printhead.

Market Requirement

There are three market requirements to expand thermal ID card printer market.

1. Fast heat response feature (High speed printing)
2. High scratch resistance feature (High durability)
3. Angle adjustment free (Reducing assembly load)

Those requirements are mostly from the ideas to improve print quality and speed. Angle adjustment free requirement is to reduce the assembly load at printer manufacture.

The factors involved in above item 1 to 3 are listed in the table below. All the factors except for glaze related have already been improved and implemented to current printheads. One example is resistance profile. Resistance profile of true edge printhead is trimmed to be almost flat. Then, the next design theme is to improve the glaze flatness, thickness and curvature.

Table 1. Factors to Affect for Three Kinds of Requirements

	Factor 1	Factor 2	Factor 3
Photo quality	Resistance profile	**Glaze flatness**	
Heat response	**Glaze thickness**		
Scratch resistance	Overcoat hardness	Overcoat thickness	**Glaze curvature**
Angle adjustment	Heater position	**Glaze curvature**	

The Concept of H Series

Glaze thickness of current true edge printhead is 75um. To make the heat response faster, heat accumulation must be smaller. The heat accumulation is involved with the heat level. To reduce it, glaze thickness should be thinner. Since this printhead is mostly used with D2T2 ribbon that requires a certain energy level, we chose the same glaze thickness as that with flat type printhead based on our long experience in D2T2 technologies. As a result, 55 um glaze thickness is chosen for H series.

Another factor is glaze curvature. The current curvature radius is 1.34 mm. To reduce the partial pressure in contact area of heater and to apply the same pressure in wider contact area, glaze curvature should be designed larger.

One of the long seller card printer printhead, KSL series, has flat type printhead structure. The glaze curvature radius of KSL series is 3.5 mm, and it is applied to H series substrate.

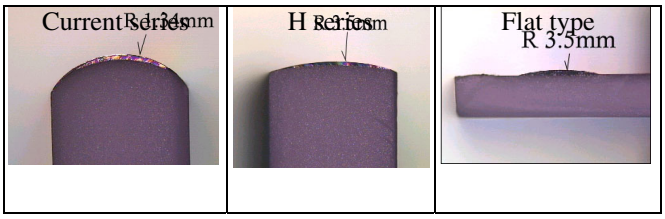

Figure 2. Cross section of the substrate

Glaze Flatness of H Series Substrate

Both glaze flatness and resistance profiles are the key factors to have excellent printing quality. In particular, it is more sensitive to print on a stiff material such as plastic card rather than to do so on flexible photo printing paper.

Below Figure is showing the measurement data of surface profile of H series printhead.

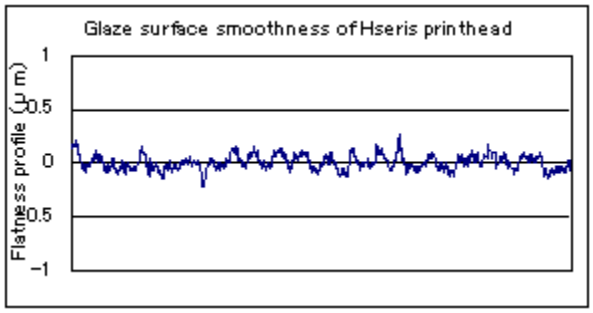

Figure 3. H series surface smoothness

It is showing quite smooth surface profile on the heater line.

We have another straight pass capable printhead so-called near edge offset type printhead as shown in Figure 4. And Figure 5 is the profile shown with the white arrow in figure 4. For straight pass printing, heater line, which is tangent to the glaze, needs to be located so that it will not come into contact with IC hard coat.

Surface profile of near edge offset printhead is also shown as comparison with that of true edge printhead.

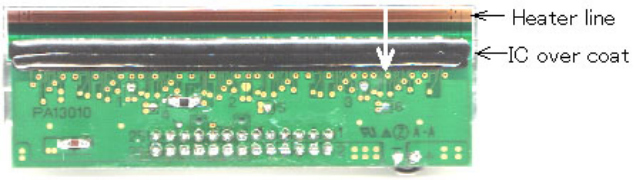

Figure 4, Kyocera near edge printhead

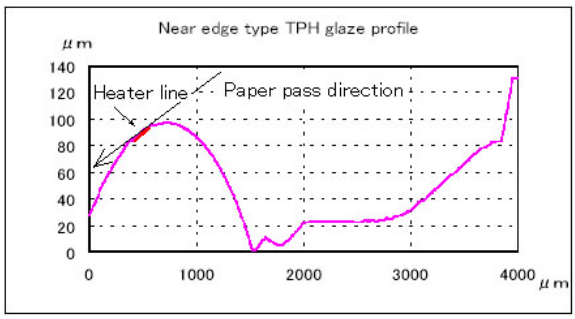

Figure 5, Profile of near edge printhead which is the white arrow in the Figure 4.

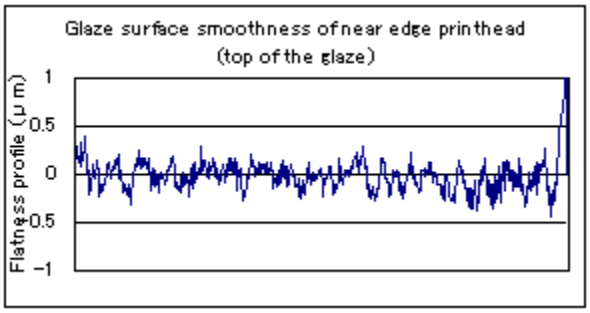

Figure 6. Near edge printhead surface smoothness (top)

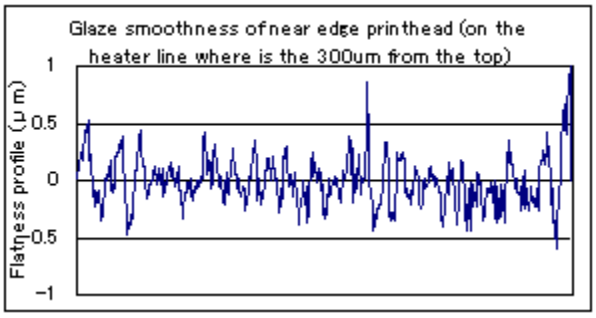

Figure 7. Near edge printhead surface smoothness (300 um)

The glaze surface profile of near edge printhead is not as smooth as that of H series. The glaze surface under heater line is not so smooth as that at the glaze top. As a nature of the glazing process, the surface smoothness is gradually degraded as it is away from the top. In general, the edge of the glaze is waving. This waving affects the glaze smoothness. If the glaze width is larger, the surface area contacting to printing media becomes smoother. H series is designed to have a wider glaze than conventional flat printhead is. The glaze width of H series printhead, which is the same as glaze thickness, is 2 mm while that of conventional flat printhead is narrower. This is why "H" series has a smoother glaze surface in media contacting area than near edge printhead does.

Improvement of Scratch Resistance

When printing is performed on the stiff material, higher scratch resistance is required. This scratch resistance is related with overcoat specification such as hardness and thickness, and also platen pressure.

Below chart is showing the result of scratch test using lapping film. Three different overcoats are applied to current true edge printhead samples. The difference is thickness. KT14 is two times thicker, and KT16 is three times thicker than KT12. And one more sample is H series with KT12 overcoat.

Test conditions are as follows;

Al_2O_3 lapping film with 40um particle size passes through between printhead and platen with various platen pressure (which shows on the Y axis in the chart).

The width of lapping film is 3cm. It covers about 350 elements. The number of failed elements is counted after the lapping film has passed through in each platen pressure.

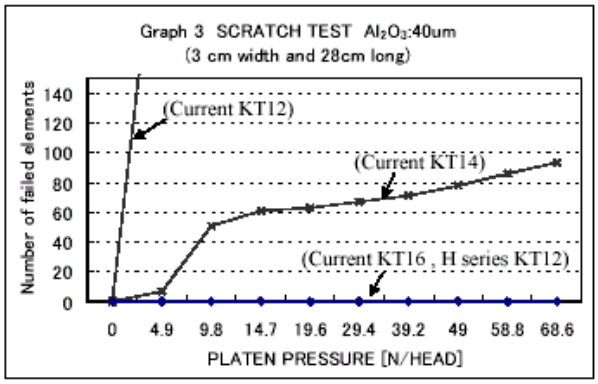

Figure 8. Result of scratch test by lapping film

This test result is showing the excellent performance of H series scratch resistance. Its performance is almost equivalent to current true edge printhead with KT16 overcoat. Further enhancement is expected as overcoat thickness is increased.

Media Contact with H Series

As mentioned, one of the requirements from the market is angle adjustment free printhead. When printhead is assembled to ID card printer, printhead installation angles needs to be adjusted to have optimum printing quality. To find a correlation between offset angle and optical density, the testing was performed with both H series and current true edge printhead. The resin base transfer ribbon is used for testing owing to its sensitive feature against contact rather than D2T2 ribbon. The test conditions are with 20 mm platen roller, and the angle pivot locates in the center of glaze curvature. The result is shown in Figure 9.

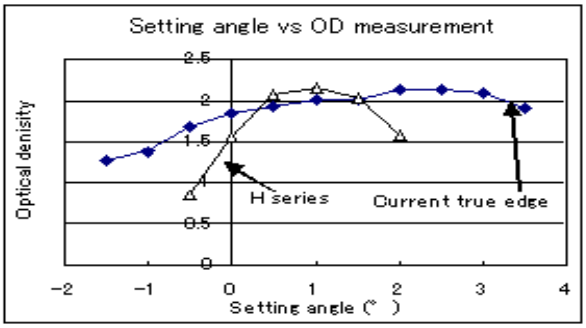

Figure 9. Result of scratch test by lapping film

The chart is showing that H series has the "sweet spot" in narrower angle range and uniform inclination of optical density per change in angle, while the current true edge is showing that the "sweet spot" is distributing in the wider range and uneven inclination of optical density per change in angle. This feature is expected to contribute to less adjustment efforts at the time of printhead installation. Since the adjustable angle will be narrower with H series, the relation between heater line position and tangent point of platen roller will be more sensitive and this factor may need to be addressed simultaneously.

Heat Characteristics

The glaze thickness of H series printhead is changed from 75 um, which is the glaze thickness of current true edge TPH, to 55um. This difference of the thickness corresponds to optical density. For verification, both H series printhead and current true edge printhead are used for testing. Optical density is measured from the thermal paper printed at the same energy level. The result is that current true edge printhead shows darker optical density than H series does at the same energy level. The result was exactly as we expected. H series thinner glaze has less heat accumulation, while it has higher heat response. This trade-off comes from the nature of glaze characteristics.

From this result, H series printhead has the potential to increase the print speed with maintaining the print quality when higher power is applied.

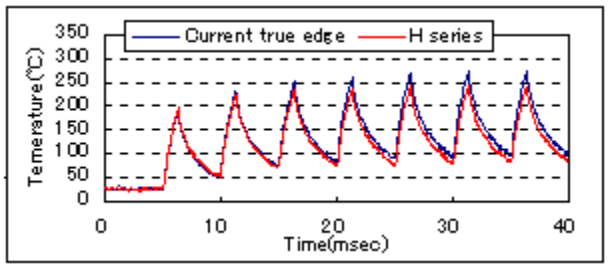

Figure 10. Temperature on the heater (Heat efficiency)

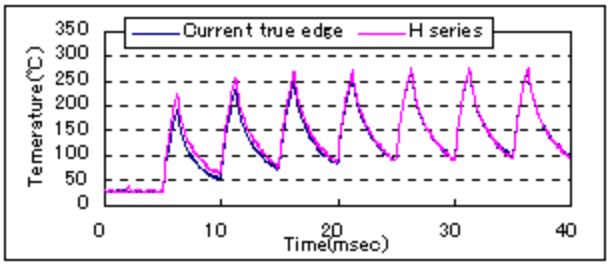

Figure 11. Temperature on the heater (Heat response)

Improvement of the Thin Film Process

To mass-produce H series printhead, there is a production process that requires improvement. This is the patterning process at the corner of the glaze. To have larger curvature on ceramic edge, the corner of the glaze becomes very sharp. In general, photo-etching process is applied to form electrode patterning. However, the thickness of the photo resist will be very thin at the corner, which leads low production yield. In order to produce H series printhead, we have to overcome the difficulty in photo resist process. Finally it is resolved by taking special resist coating processing method, which cannot be disclosed at this moment. The figure below is showing the SEM picture at the corner of the glaze. We see that the patterning is perfectly formed.

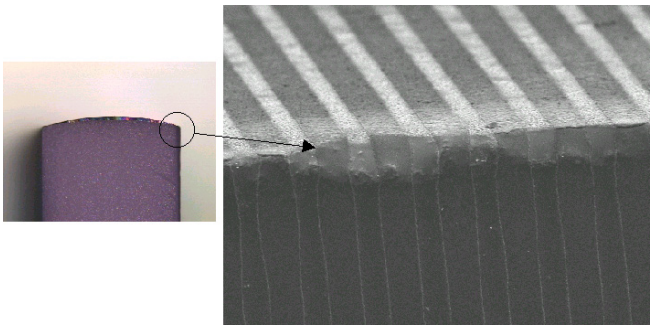

Figure 12. Electrode pattern at the edge of the glaze

Resolution of True Edge Printhead

300dpi resolution is available with H series printhead today. On the other hand, 600dpi resolution is required to print Asian fonts as well as graphic images. Below is showing an example of printout comparison using the current true edge printhead. Obviously, 600dpi characters are smoother than that from 300dpi. 600dpi will be attractive option for card printing application.

300dpi	
600dpi	

Figure 13. Comparison between 300dpi and 600dpi printing

Conclusion

True edge H series printhead has wider contact area to print on stiff printing media. This may eliminate a troublesome printhead angle adjustment process from printer assembly line.

Thinner glaze provides quicker heat response. The degradation of heat efficiency still requires to be improved to achieve higher speed, though.

The scratch resistance is improved very significantly to extend printhead life in ID card printer.

We hope our H series will enhance the product value to ID card printer manufacturers as well as users in the market. We would like to contribute to the growth in the society through our development efforts.

Biographies

Hidekazu Akamatsu graduated from Ehime University in 1988 with a degree in Physics. He received a Masters Degree in Science from Ehime University in 1990. His major was Magnetism. He joined Kyocera Corporation in 1990 working in the Application Engineering Department. He worked in the North America thermal printing market, living in Vancouver Washington from 1997 to 2001 and presently serves as Leader, Unit 3, Application Engineering, Thin Film Device Division, Hayato, Japan .for Kyocera Corporation.

Yoshiaki Kutsuzawa graduated from Seikei University in 1992 with a degree in Electronics. His major was micro device. He joined Kyocera Corporation in 1992. he is working as a application engineer.