Development of high speed real edge printhead for card printer

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Abstract

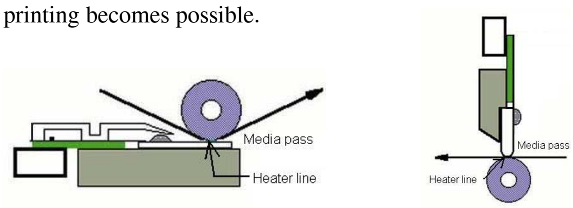
Faster print speed for on demand type card printing is one of the strong requirements from the printer user. And, it must include graphic quality to describe the full color photograph for ID card using dye diffusion thermal transfer method.

To achieve these requirements, there are obstacles to be solved. One of those is the ribbon wrinkle. When print speed is increased, friction between heater of thermal printhead and the back coat of transfer ribbon will be bigger. As a result, ribbon wrinkles much easier compared to regular speed. To reduce it, printhead heater construction has been improved. As a result, wrinkle could be eliminated.

Thermal printhead for card printer

There are two styles of thermal printheads. One is flat type printhead which is most popular and reasonable. The other style is edge type printhead. Especially, real edge type printhead is used for a card printer.

The principle feature of flat type printhead is that the heater line is positioned on the widest dimension of a ceramic substrate. Also, driver IC is located on that same surface. As a result, the media pass needs to have some angle to avoid touching the driver IC and it is bent along the platen surface. The other hand, real edge printhead has heater line on the real edge. Then, there is nothing before and after heater line. As a result, straight pass printing becomes possible.



Flat type printhead Real edge type printhead

Figure 1. Printhead type

There is a corner edge printhead which is also straight pass printhead. However, this printhead is mostly used for an extremely high speed application which is date code printer. It doesn't require photo quality. Real edge printhead is designed specifically for photo quality application. This is the reason why real edge printhead is adopted by a card printer.

Printhead angle adjustment

When printing on plastic card is done by real edge printhead, angle adjustment is one of the most important factors to keep print quality. Printhead angle may not be perpendicular against printing surface as shown in Figure 2.

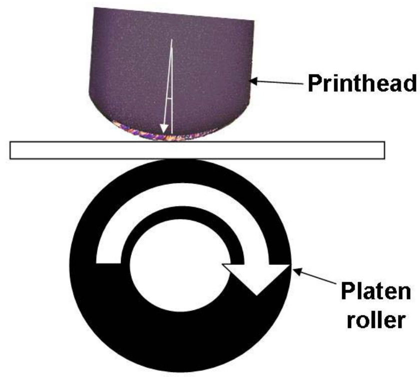
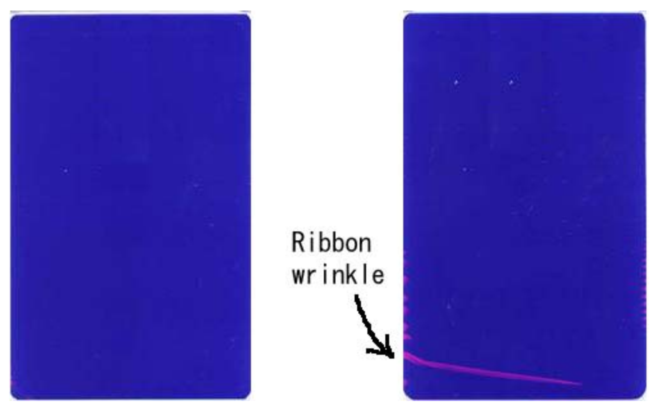


Figure 2. Printhead angle adjustment

Especially, photo quality printing with dye sublimation method is significant. If heater line is directly on the media pressed by platen roller, dark image printing makes ribbon wrinkle and it appears on the plastic card as an image shown in Figure 3.



No ribbon wrinkle Image with ribbon wrinkle

Figure 3. Card images with and without ribbon wrinkle

To avoid this ribbon wrinkle, printhead needs to be slightly tilted to make contact worse between printhead heater line and media. The other hand, if printhead is tilted too much, print quality is degraded by poor contact between heater lines and media as well as light optical density. This phenomenon is fairly well known in the card printer industry. Also, most of all card printers have their own adjustment method to keep print quality optimum.

Cause of ribbon wrinkle

There are a variety of causes for ribbon wrinkle. However, any cause by mechanical reason will not be discussed in this paper. Most of all mechanical causes can be solved by printer mechanism without printhead modification. In this paper, mostly friction between printhead heater line and media will be discussed. Especially, media is dye sublimation ribbon and plastic card.

Darker image may make more ribbon wrinkle than light print. This is the reason why angle adjustment needs to be done with dark image. Darker image requires more heat than lighter image. It means printhead heater surface temperature is increasing with dark image. This temperature is a cause of high friction between heater line and media surface. From this, we could find that higher temperature makes higher friction between heater line and ribbon back coat.

And, the other hand, ribbon wrinkle can be removed by tilting the printhead angle to make contact worse between heater line and media. This moves the contact of the media away from the center of heater so that it is shifted toward location between center of heater and the edge. Figure 4 shows how temperature distribution of printhead heater and media contact location is shifted by tilting the printhead. Peak temperature of this contact location is slightly less than center of the heater. Then, as a result, friction can be reduced to avoid ribbon wrinkle.

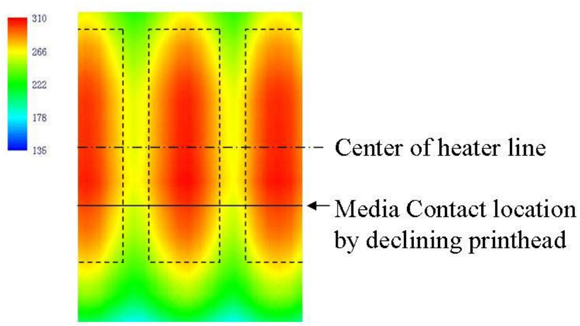


Figure 4. Temperature distribution of heater

Optimum angle window with high speed printing

Currently, print speed of ID card printer is about 1.0ips to 1.5ips by dye sublimation transfer method. Then, when this print speed will be increased, we are interested in what the optimum angle window will be. Figure 5 shows the experiment of print speed 1.28ips, 1.67ips and 2.38ips. Thermal printhead construction is as below.

Printhead type : Real edge (ref. Figure 1)
Resolution : 300dpi
Glaze type : Partial glaze type.
Overcoat : Type A. (Ref. Overcoat material)

It is a kind of world wide standard printhead. In this sense, it can be a good reference.

Figure 5 shows the result. Print speed and tilted angle of blue color filled box has successfully adjusted without ribbon wrinkle and print quality degradation. However, there is no optimization window to keep both no ribbon wrinkle and no print quality degradation with 2.38ips print speed.

Tilted angle		1°		2°		3°		4°		5°	
2.38ips											
1.67ips			■								
1.28ips		■	■								

Figure 5. Angle adjusted window of standard printhead.

From this result, ribbon wrinkle will be a significant problem to increase the print speed. It means to achieve high print speed like 2.38ips, ribbon wrinkle should be removed.

Glaze construction for high speed printing

To remove ribbon wrinkle with high speed printing, printhead needs to be tilted further down to have more angle. However, it results in print quality degradation. To avoid this quality degradation, double partial glaze construction can be considered. Related subjects are in the reference [1]. Figure 6 shows the partial glaze and Figure 7 shows double partial glaze. Obviously, double partial glaze can make better contact with media than partial glaze.

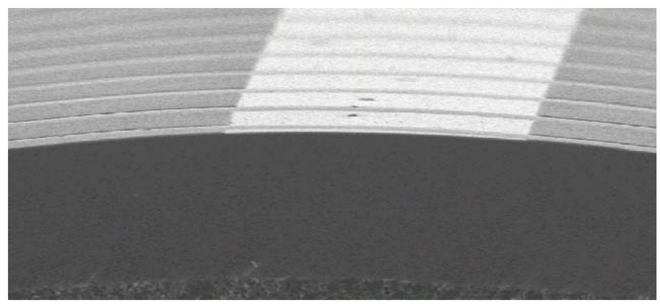


Figure 6. SEM picture of Partial glaze cross section

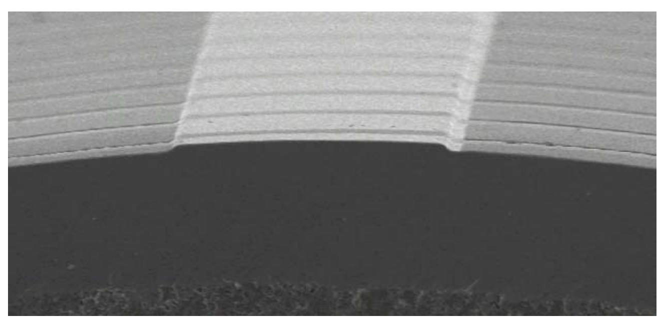


Figure 7. SEM picture of double partial glaze cross section。

Overcoat material

Ribbon wrinkle is also related with the printhead overcoat material. Mostly, it was from experience with digital photo printer application. When evaluation of angle window with double partial glaze was performed, different overcoat material was also evaluated. However, this material will not be disclosed in this paper.

Angle window with double partial glaze

This evaluation is done by same method as partial glaze. Printhead construction is as follows;

Printhead type : Real edge (ref. Figure 1)
Resolution : 300dpi
Glaze type : Double partial glaze type.
Overcoat : Type A and Type B

Evaluation result is as Figure 8 and Figure 9.

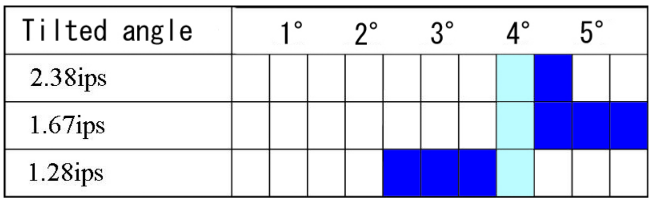
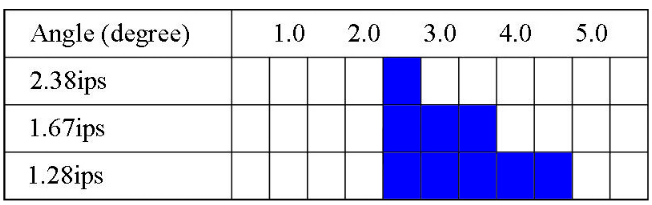


Figure 8. Angle window of double partial glaze with Type A overcoat



Figurer 9. Angle window of double partial glaze with Type B overcoat.

Angle of blue color filled boxes makes optimum print quality without ribbon wrinkle. And, light blue angle is very marginal and may be small ribbon wrinkle. This angle may not be accepted by commercial printer.

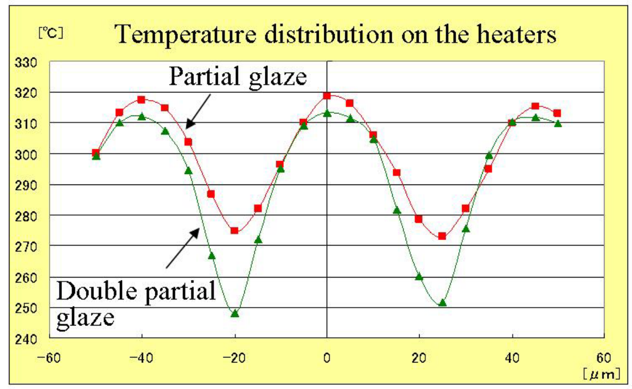
From this result, we can find that the optimum angle of double partial glaze shows 2.5 degree to over 4 degree with 1.28ips print speed for both overcoat materials. It is more tilt angle than partial glaze which is about 1 degree to 1.5 degree. Also, there is a window with 2.38ips which is high speed and no window with partial glaze.

The difference between Type A overcoat and Type B overcoat is the existence of common window for all print speed which is same optimum angle. Type A is 4 degree but very marginal. However, Type B has 2.5 degree as a optimum angle for all speed range.

As already mentioned in above section, the difference of overcoat material will not be discussed in this paper.

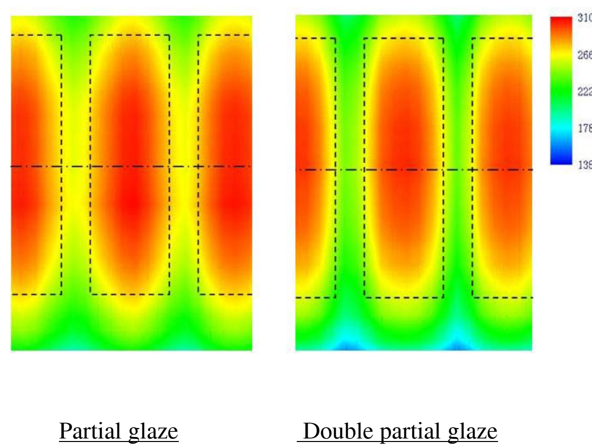
Effect to remove ribbon wrinkle

Double partial glaze printhead has wider optimum angle window than partial glaze printhead. One of biggest difference is physical contact. Obviously, double partial glaze is better than partial glaze. Better contact makes better heat transfer. As a result, double partial glaze printhead will be better heat efficiency than the other. It means double partial printhead can get the same optical density as partial glaze even lower temperature of the heater. Figure 10 shows temperature distribution chart to get same optical density. Highest temperature location is the center of the heater and lowest is between heaters. Temperature of double partial glaze printhead is lower at either center of the heater and between heaters.



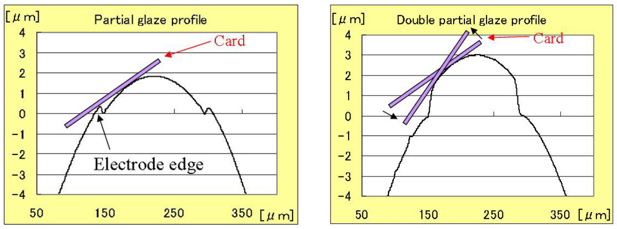
Figurer10. Temperature distribution chart on the heaters (Scanning direction)

Also, figure 11 shows the temperature distribution by color. From this result, double partial glaze heater shows more rectangle shape of temperature distribution than partial glaze. It is from difference of heat flow. Double partial glaze has another partial glaze on the heater. Then, it becomes another heat mass and heat dissipation flow must be going down first. Then, spread out especially both IC side and common side direction.



Figurer11. Temperature distribution on the heaters

Also, double partial glaze provides better physical contact than partial glaze. It makes further tilt angle than partial glaze without contacting card to the electrode edge. Figure 12 shows the difference. This is the reason why double partial glaze printhead can accept over 4 degree tilt angle without degrading the print quality. Then, it becomes wider optimum angle window with double partial glaze than partial glaze with 1.28ips print speed. And, it is the reason of existence of optimum window with 2.28ips print speed.



Partial glaze   Double partial glaze

Figure 12. Surface profile of heater (sub scanning direction)

Conclusion

Print speed of dye sublimation transfer card printer is currently 1.0ips to 1.5ips. Then, to increase the print speed, difficulty is to optimize the printhead angle to remove the ribbon wrinkle at high optical density. Using current standard partial glaze printhead, there is no optimum angle window at 2.38ips. To get optimum angle window where there is no ribbon wrinkle and no degrading the print quality, double partial glaze printhead is one of the solution. This double partial glaze printhead has wider optimum angle window with 1.28ips which is standard print speed. And, there is optimum angle window even at 2.38ips. Double partial glaze heater contacts to the media better than partial glaze. It makes two kinds of benefit. One is better heat transfer. And, the other is wide tilt angle without contacting card to the electrode edge.

This real edge type double partial printhead is the optimum printhead to achieve higher print speed of dye sublimation card printer.

References

[1] Hidekazu Akamatsu, Maximum performance of printhead (IS&T, An courage AL, 2007) pg. 142.

Author Biography

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 a manager of Application Engineering 2, TPH Division, Kirishima Japan Kyocera Corporation.

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