Development of ultra high density thermal printhead

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Abstract

Recently, resolutions of printing devices are increased rapidly. Obviously, higher density makes better quality for any type of print. In regard thermal printing technology, highest density of mass production printhead is 600dpi except for the particular application of higher density than 600dpi with small quantity. To search the possibility of much higher density by thermal printing method, Kyocera developed 2400dpi and 4800dpi thermal printhead, and made printouts successfully. Printouts by those ultra high density thermal printhead are too small to see by naked eyes. Microscope is required to see it. The other hand, there are issues to solve as thermal printing with this ultra high density. In this paper, future possibility and issues of ultra high resolution thermal printing are introduced. Also the new potential application will be discussed.

Feature of high resolution

Resolution of recent printing devices becomes quite high. Especially, graphical print image like photograph may be more than 1000dpi (dots per inch). The other hand, resolution of thermal printhead is typically 200dpi and 300dpi. And, even highest resolution of production printhead is 600dpi except for some specific application which are quite small volume. Those might be 900dpi to 1200dpi.

One of the reasons why thermal printhead doesn't become high resolution like other print method is that existing application doesn't require it strongly. For example, 300dpi density of photograph printing by dye sublimation method is equivalent quality as more than 1000dpi inkjet printing. There is no reason to adopt such high density with dye sublimation printing.

However, we don't know how over 1000dpi thermal printhead will work. At least below features must be improved.

1. Amount of information in unit area
2. Number of gray levels by area modulation method
3. Quality of character print

In this paper, we discuss about the advantage to use ultra high resolution thermal printhead which is up to 2400dpi. Also, experiment of printing by 4800dpi thermal printhead which is highest density thermal printhead in the world will be discussed.

Thermal printhead heaters

Heaters of thermal printhead which is used for printing experiment are as figure 1. 300dpi is typical density for the most of all thermal printing application. This heater pitch is 84.7um. The other hand, 2400dpi printhead heater pitch is only 10.6um. This is eight times smaller heater pitch and sixty four times smaller heater area. This difference is obvious. For the high resolution heaters, optimization of heater gap, electrode height and heater size are important.

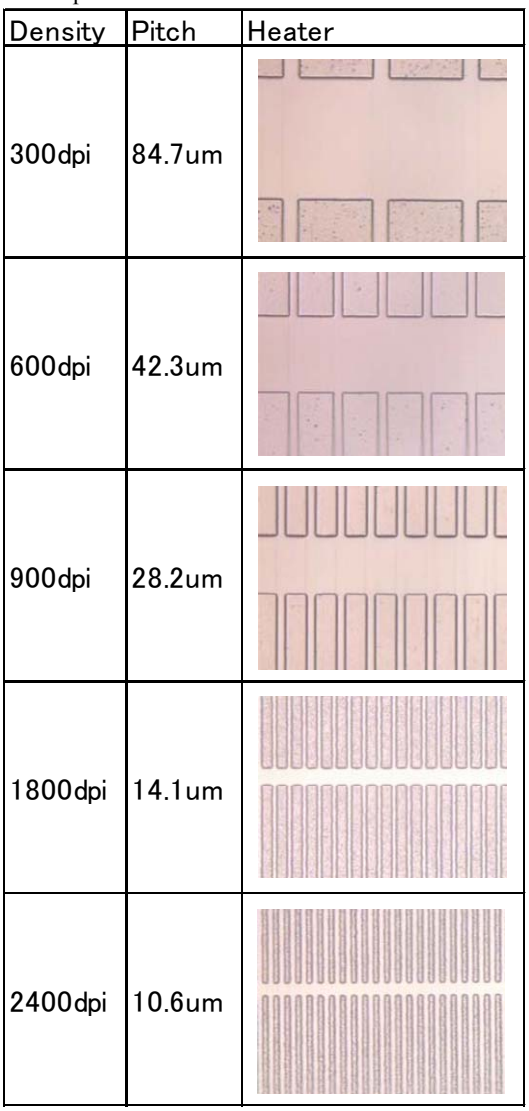


***Figure 1**.Printhead heaters*

Print speed

Print speed is determined by heater length and Tcy which is time cycle for one printing line. Usually, we regard effective heater length is same as heater pitch except for the case intentionally designed it to longer or shorter. Then, print speed is as shown in the chart of figure 2.

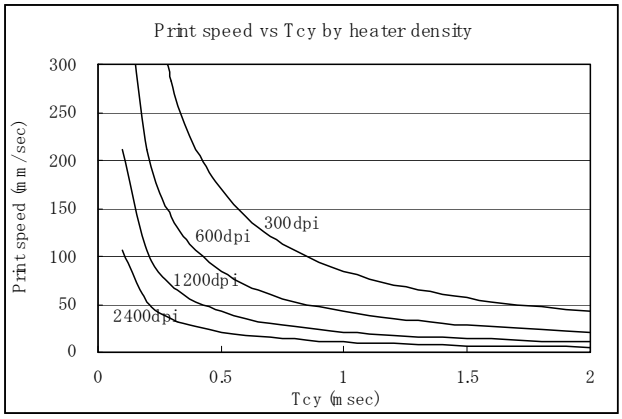


Figure2. *Print speed vs. Time cycle by heater density*

To achieve faster print speed, shorter Tcy is required. The other hand, shorter Tcy can be a cause of heater burn out failure. It is the phenomena which temperature at the center of the heater may exceed the acceptable level even to get just printable energy. This pulse durability may be a limitation of print speed.

At this time, we just investigate the printouts by high density printhead. In this paper, limitation of the print speed by high resolution printhead will not be discussed. And, print speed of the printouts in this paper is set to about 1mm/sec which is quite slow to eliminate any remaining heat in the heater area. So, in other words, optimization of heat accumulation is important and it must be controlled. Also, we know the print speed is one of important factors for the printing. When this over 1200dpi resolution printhead will be used in any application, print speed shall be considered.

Simulation of heating process

In a printing process by thermal method, heater needs to achieve enough temperature to print. Figure 3 shows the calculation result of temperature behavior of 300dpi and 2400dpi heaters. Applied power per unit heater pitch for both 300dpi and 2400dpi are same. If heater length is same, achieved temperature should be same.

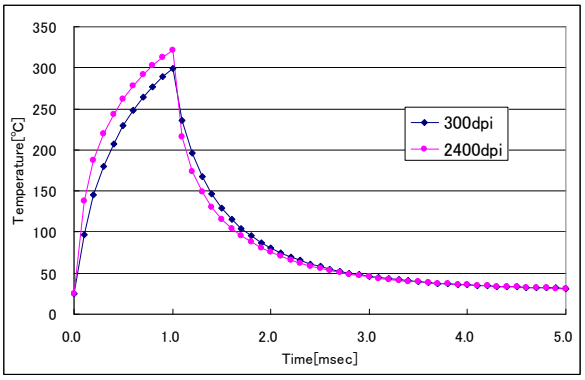


Figure3. *Simulation result of heating process of 300dpi and 2400dpi heater*

In this calculation, 2400dpi heater length and width ratio is also same as 300dpi heater. As a result, 2400dpi heater temperature goes to slightly higher than 300dpi and cooling process is slightly quicker than 300dpi. From this result, high resolution heater can achieve enough temperature to print.

Printouts of high resolution printhead

Figure 4 is the magnified picture of 300dpi and 2400dpi printouts by resin transfer ribbon. Both printed data are exactly same. From these printouts, we can see the exactly same information by 300dpi printhead is put in a smaller area by 2400dpi printhead without significant print quality degradation.

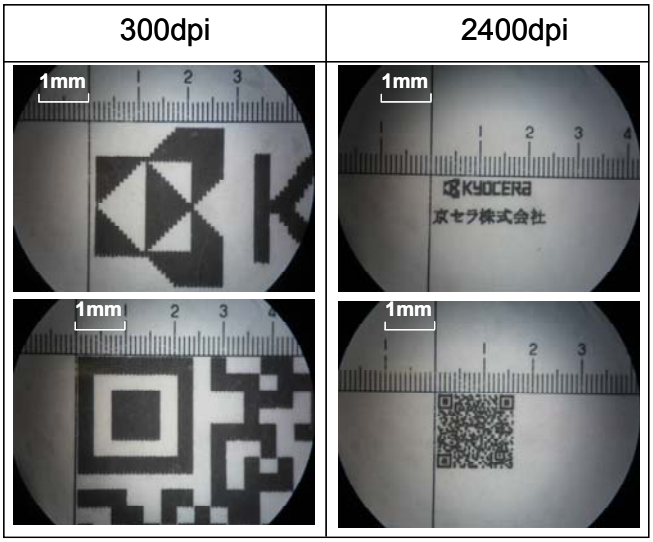


Figure4. *Printouts of 300dpi and 2400dpi printhead*

Figure 5 shows the overview of the 2D codes by various densities of printheads. This comparison is just showing the area to put the same information by various densities visually.

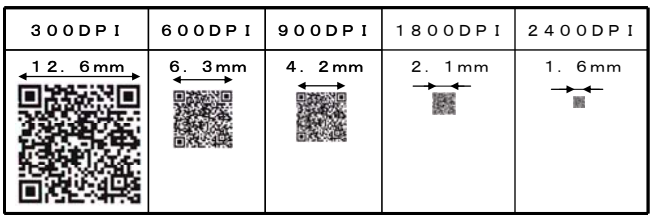


Figure5. *Printouts of 300dpi and 2400dpi printhead*

To make this printout better quality, two kinds of characteristics needs to be improved. One is contact by electrode height and overcoat. The other is optimized heat accumulation and dissipation characteristics for this heater size.

4800dpi thermal printhead

We also developed the world highest resolution thermal printhead which is 4800dpi for investigation purpose. And, it could print successfully by thermal transfer method. Figure 6 shows the magnified picture of 1200dpi and 4800dpi printouts. This success of 4800dpi thermal printing is significant.

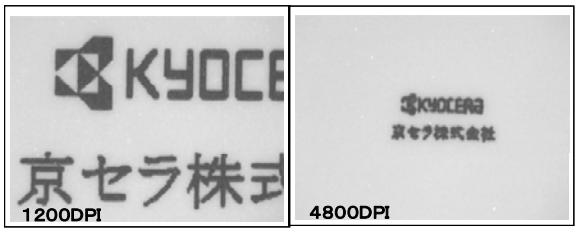
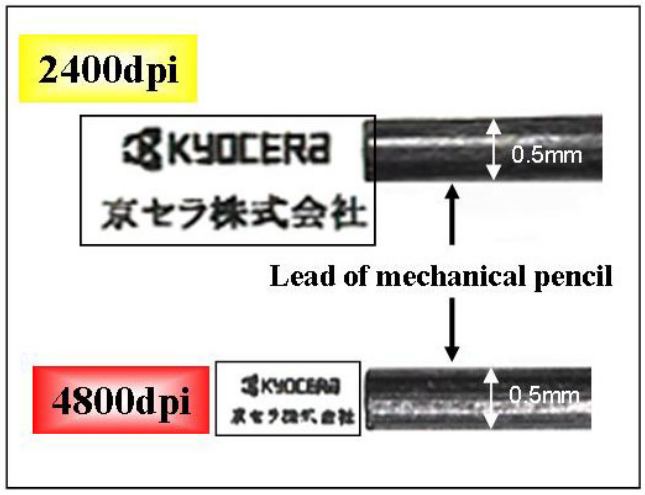


***Figure6**. Print result of 1200dpi and 4800dpi thermal ptinehead*

Figure 7 is the size comparison between the lead of mechanical pencil and printouts by 2400dpi and 4800dpi printhead. From it, we can recognize how those printouts small are.

***Figure7**. Size comparison of high resolution printhead and lead of the*



mechanical pencil.

Issue of high resolution thermal printhead

During our process to make printouts using ultra high density printhead, we found three issues need to be solved to achieve higher speed than experiment.

1. Heat efficiency
2. Pulse durability
3. Contact with media

When those extreme high resolution printheads will be used with certain application, at least practically usable print speed will be required. Also, contact with media is very important for the print quality as well as the speed.

Issue of high resolution thermal printing

The other hand, to maintain the print quality by thermal method, media surface needs to be smooth, especially for high resolution.

And, due to the small line pitch of sub scanning direction, media of line feed is very important to keep the print quality. This line feed precision is equivalent as the heater pitch of scanning direction.

When printer mechanism and media are developed, above issues must be considered.

Considerable usage of ultra high density TPH

From all consideration of ultra high density TPH, following items are the listed as advantage of it.

1. Amount of information in a unit area by 2D code
2. High quality of complicated Asian character print
3. Micro character printing

Also, we have two issues to be solved, one is the print speed related and the other is print quality related. When new application with those ultra high density thermal printhead will be considered, those issues must be solved as well.

Then, primary targets as new usage will be as follows;

1. Security by micro character.
2. Higher information density by 2D code
3. Asian complicated character printing
4. Any applications which require the heating in a quite small area other than ordinal concept of printer

Conclusion

In this paper, printouts by the ultra high density thermal printhead are discussed.

First of all, high density printhead which are 2400dpi and 4800dpi could print using thermal transfer method. This result is quite encouraging us to consider even higher resolution thermal printer.

The other hand, still there are issues to be solved before bring it to actual application. One is the print speed. At this time, print speed was just 1mm/sec for the evaluation purpose only. To make it faster, printhead heat efficiency, pulse durability and media contact should be improved.

Also, there are two issues for the printing itself. One is media feed by printer mechanism. This media feed precision is the same meaning of heater pitch of scanning direction. The other is media smoothness. If there is any void on the media, it will not be printed. Obviously, it will be a cause of print degradation.

Then, following usage will be considered as a new application

1. Amount of information in a unit area by 2D code
2. High quality of complicated Asian character print
3. Micro character printing

However, any investigation of this ultra high density printhead has just started. We are hoping this technology will help to expand thermal printing application.

Author Biography

Youichi Moto graduated from Hiroshima Institute of Technology in 1991. His major was Electronics. He joined Kyocera Corporation in 1991 working in the R&D Department for thermal printhead. He worked also Ink jet printhead development as well as thermal printhead. Presently he serves as a manager of Enhanced technology development section, TPH Division, Kirishima Japan Kyocera Corporation.

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