Latest New Technology of Thermal Printhead

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Market Demands

In recent years, thermal printer market does not only stay in POS or ECR, but it is expanded to variety of applications. Especially gaming machines and lottery machines started to employ thermal printhead worldwide. Also, photo printer market has become very important market as the quantity is increasing drastically year by year.

Since thermal printhead market has many applications, this time I would like to concentrate on three big markets, which are Mini printer Market, Barcode label printer Market, and Photo printer market. I would like to introduce their market demand.

Firstly, for Mini printer market, whose main applications are POS, ECR, etc. and the biggest market demand is small size and energy saving.

Secondly, for Barcode label printer Market, there are strong demands for high speed and high print quality.

Lastly, for Photo printer market, it is divided into consumer market and industrial market. Consumer market requires small size and energy saving. On the other hand, industrial market requires high speed and super high print quality.

I would like to explain their technical solutions for those three markets.

Mini Printer Market

At the Mini printer market, biggest demands to printhead are smaller size, energy efficiency, and improvement to sticking issue. For smaller size, there is background that the printer itself is going towards smaller size and also the market price has been reduced. For energy efficiency, it is closely related to the fact that the battery has become longer life. For sticking issue, by increase of the market, products are now used at variety of environments and there are many types of media recently (not only good ones but also bad ones), which leads to people become more sensitive to this issue.

Development for Small Size

Firstly, I would like to explain about the development for small size and good cost performance. The smallest size of current models is 54 × 11mm, and for the new model, by applying "Direct connecting structure", there is no need to mount the connector. This allows the size to become 10mm from 11mm.

Moreover, by the further development, the size becomes much smaller such as 10mm to 7.78 mm. Also, its width becomes 52.8mm from 54mm by keeping the same print width of 48mm. By this development, the size becomes suitable for small mechanism, but it can still be applied to 8mm platen. Also, the resolution is changed from 200dpi to 150dpi for better cost performing.

Development for Energy-Saving

For better energy saving, heat storage is important matter. However, we are also trying to develop the energy efficient head by considering other factors such as heat response, contact with media, and productivity. For these characteristics, the glaze structure under the heat element is important and so I would like to explain about the general glaze structures and their features.

Table 1: Characteristics of Each Glaze Structure

	Full glaze	Partial glaze	Double glaze
Cross section			
Heat storage	A+	B	A
Heat response	B	A+	A
Contact with media	B	A	A
Productivity	A+	A	B to A

Full glaze has good characteristics for heat storage, and it is widely used at the current mobile type of application. However, the heat response is not as good as other glaze and also contact with media is not good because it is flat shape. But its productivity is very high.

On the other hand, Partial glaze does not have good heat storage characteristics compared to full glaze but it has good characteristics for heat response and contact with media is good as well because of its convex shape. Its productivity is not as high as Full glaze type, but Partial glaze is widely produced for middle/high speed printing thermal head.

The structure, which has good characteristics from both Full and Partial glaze, is Double glaze. It secures heat storage with high heat response, and also it has good characteristics for the contact with media. However, usually production of this glaze is rather difficult so that its productivity is not so high. We are now trying to develop our own production method to increase the productivity of this Double glaze, which has the best characteristics of all, and put them into the market where the energy saving is crucial.

Figure 1 shows the actual comparison of print efficiency for Double glaze structure and Full glaze structure. The dashed line is the density curve of full glaze with 100um of its thickness. It would need 0.1mJ/dot to reach Optical density of 1.2. The continuous line is the density curve of double glaze, which has 200um of the thickness at the heat element part. It would only need 0.075mJ to reach Optical density of 1.2. Therefore, when looking at Optical Density 1.2, energy has become efficient by approximately 25%.

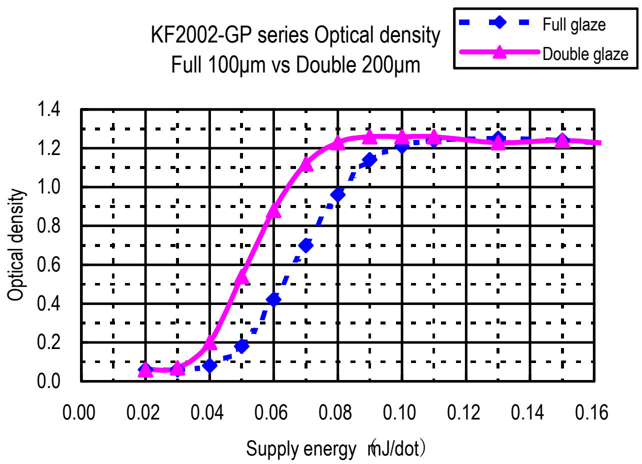

Figure 1. Optical density vs Supply energy

Barcode Label Printer Market

The demands from barcode label printer market are high-speed print and high print quality.

The reason of high-speed print is especially because of the demand increase at the logistics industry and also on-demand printing for industrial use.

Reasons of high quality print are to prevent misreading of barcode, and rapidly increasing 2D barcode usage such as QR code.

Also, at barcode labeling market, these characteristics should not be separated to each other but printers must have both high level of high-speed print capability and high quality print capability at the same time.

Approach for High-Speed Print

Usually when the print speed gets higher, the size will become far away from the ideal dot size because the heat response of the head would not be able to catch up with the print speed. Therefore, the goal of high-speed head development is to achieve ideal dot size regardless of the print speed.

Dot size is defined as follows;

-Consider the ideal dot size as 100% (for example, 125um for 200dpi is ideal dot size), and if the dot size gets smaller by fading or gets bigger by smearing, it will be expressed as the percentage compared with the ideal size of 100%.

We would like to achieve this goal by optimizing the glaze shape and by applying the new structure of the head.

New Structure "Step-Free"

Figure 2 shows the result of super high-speed print with 300mm/sec. The thin film thermal head was used for this print since normally thin film heads are used for this kind of very high-speed print.

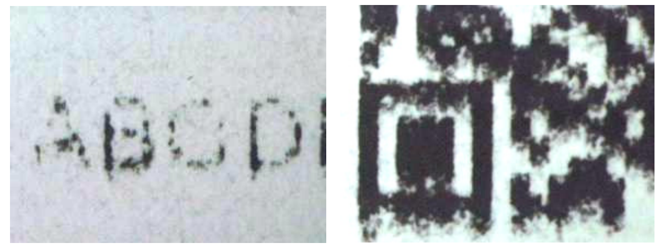

Figure 2. The result of print with 300mm/sec

This is the enlarged photograph of the print result. As you can see, the heat response of the head could not catch up with high speed and so there is fade for small character print at the point when the head starts printing. Also, for the 2D barcode print that is shown here, there is smear occurred after the print.

As this result indicates, heat response is very important for the super high-speed print. Figure 3-1 shows the cross section of the general thin film type thermal print head. There is a gap with air between the heat element and the media. This gap would work as heat insulation layer. Therefore, we paid attention to the fact that this gap affects the heat response to the media in a negative way and so we developed the head from the view that the gap should be removed. The electrode is the cause of the gap being formed. Usually, electrode is formed over the glaze, so that the thickness of this electrode forms a step and this step is the reason of forming the gap.

From this point, the picture on Fig. 3-2 is the cross section of Step-free structure, which is a newly developed model. Compared to the generally thin film structure, electrode is put into the glaze so that the step does not exist at all, and so Rohm succeeded to develop the structure, which does not have any gap between the media and the head.

Figure 4 shows the actual print result of the generally thin film structure and step-free structure. For printing small characters, which need good print characteristics at the start point of the print, the result was very much improved as you can see here. Also, smear at 2D barcode is reduced significantly and we were able to print highly clear image as a result. The reason is that the heat response is improved because the gap is removed.

Figure 5 shows the relationship between print speed and dot size for both generally thin film structure and step-free structure. For generally structure, as print speed increases, the dot size gets smaller less than 50% at the point when the head starts to print. Also, when the head continuous printing, dot size gets bigger like a

150% to 250% by smearing. On the other hand, by using step-free structure, at both points the dot size were very close to ideal size of dot although the print speed gets high, which confirms the drastic improvements of the print quality at high speed.

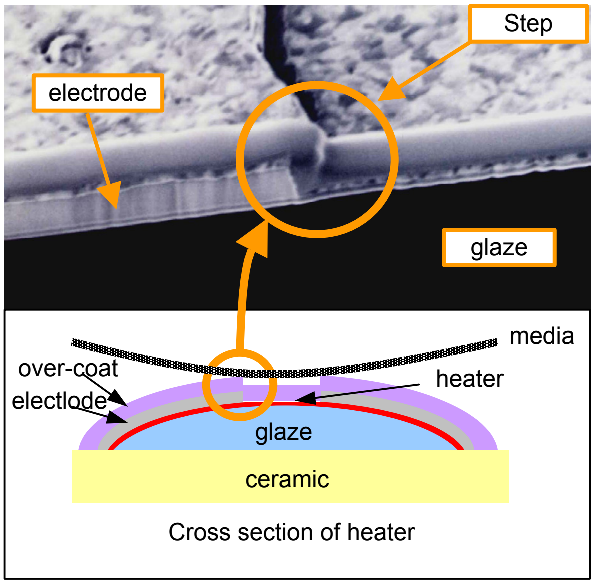

Figure 3-1. Cross section of generally thin-film structure

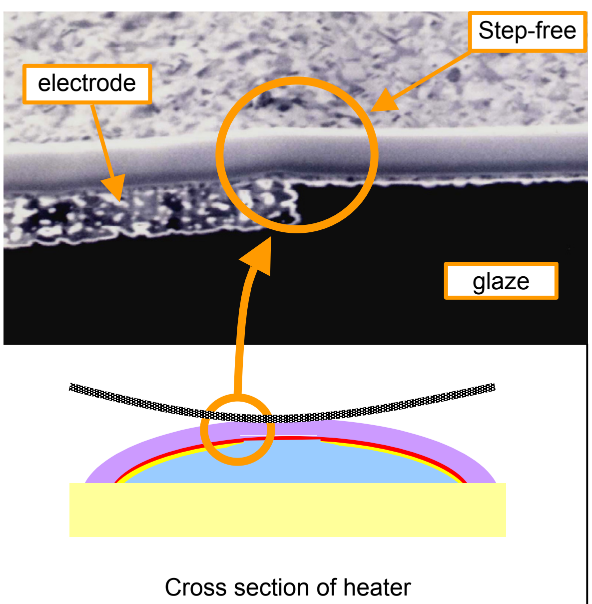

Figure 3-2. Cross section of Step-free structure

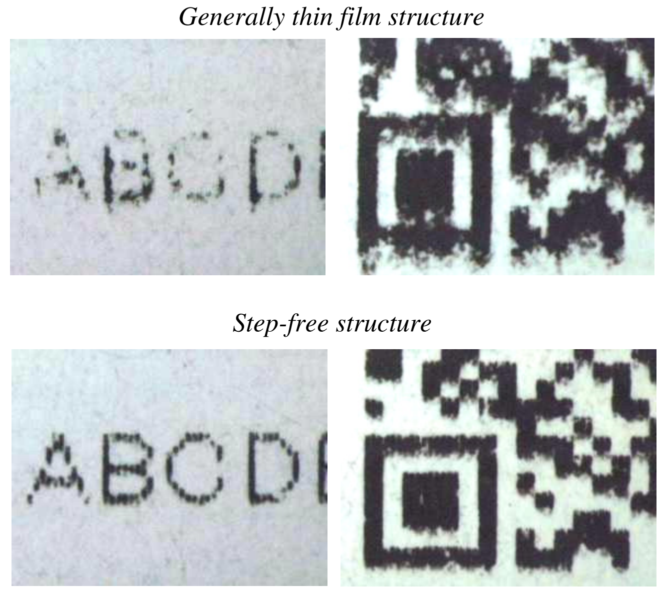

Figure 4. The result of print with 300mm/sec

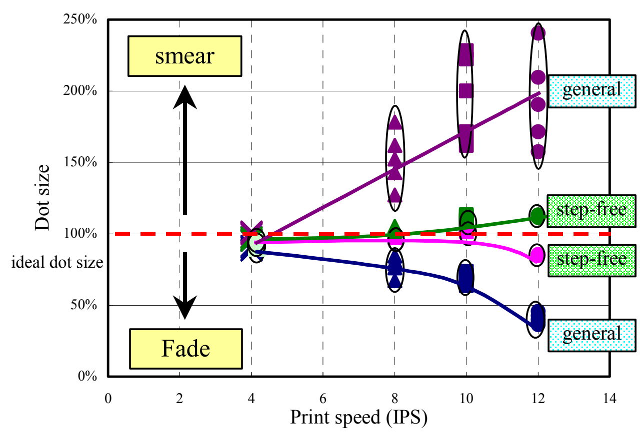

Figure 5. Relationship between print speed and dot size

Durability Against Foreign Objects

Figure 6 shows the test result of durability against foreign objects. With this test, we intentionally put foreign objects between the head and the media when printing and then measured how the resistance value would change by breaking dot with scratches. As you can see, with the general type, the resistance value was changed on many dots in the head. On the other hand, when the same test was done with Step-free type, no resistance change was measured which indicates that the Step-free structure has high durability against foreign objects.

We estimate that this is because the shock that the foreign objects apply to the head is very small compared to the generally structure since there is not step by the electrode.

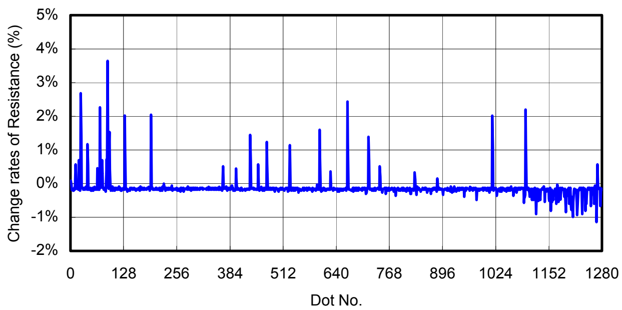

Figure 6-1. Result of durability test with generally type

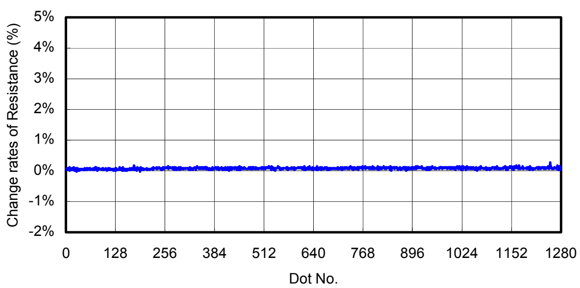

Figure 6-2. Result of durability test with Step-free type

Photo Printer Market

In terms of the demand for photo printer market, it is divided into two big directions. For the consumer model such as home printing, small size and energy-saving is demanded. On the other hand, for the industrial model such as Photo studio, Kiosk etc., high speed and super high print quality are required.

Rohm has developed VC21 series as home printing model. This series can print 4×6 size photo with approximately 60 seconds. The feature of this head is that it is small and light weight that compared to conventional VC11 series, the surface area is decreased by 35% and the weight is decreased by 23%. And VC21 series can be operated with low voltage operation and mounting high-speed driver IC. For this head, the internally developed IC for photo color TPH use is mounted and it can transfer 16MHz clock at logic voltage of 3.3V. Also, although it is 128bits driver IC, the data can be split by 64bit so that it can accommodate with multi-split data transfer, which would be required for high-speed printing in the future. Also, the over coating layer which has good heat conductivity for high-energy efficiency so that the heat generated can be transfer to the media efficiently.

On the other hand, Rohm demonstrated high-speed print for photo-color at CEATEC show, which is an electrical show of Japan, in last October. This demonstration was R&D purpose for industrial use and it could print 4×6 size photo with approximately 15 seconds, and it was paid attention by many people.

For photo printer, we are working to satisfy the demand such as energy-saving and high-speed printing. Especially for high-speed printing, we will work on aggressive development by applying the step-free structure, which was originally developed for barcode printer model.

Author Biography

Tadashi Yamamoto received his B.A. in engineering from the Osaka University (1998) and his M.A. in applied engineering from Osaka University (2000). Since then he has worked in the Printhead Division at ROHM in Kyoto, Japan. His work has focused on the development of thermal print head.