

THERMAL PRINT HEAD

This invention relates to a thermal print head, e.g. for use in a thermal printer or in a facsimile machine.

Two prior thermal print heads are shown in figures 3(a) and (b) which may be used either as serial type or line type heads. Each of these thermal print heads comprises a heat-resistant insulating substrate 11, a glass glaze member 12, a thermal or heat-generating element layer 13, and a common electrode 14. In figure 3(b), the common electrode 14 is shown as having portions on the upper and lower sides of the insulating substrate 11. Each of these prior thermal print heads also comprises an independent electrode 15 and a passivation film 16. A part of the heat-generating element layer 13 is provided on the glass glaze member 12. In figure 3(a), the common electrode 14 is constituted by the portion marked E, whereas in figure 3(b) a common electrode 14 is used which also extends to the rear side of the heat-resistant insulating substrate 11.

A thermal print head 21 has recently been proposed both for a serial type and a line type printer wherein a glass glaze member 12 on which the heat-generating element 13 is provided, is located on the side surface of the head for the purpose of improving the print quality. This is done because, as shown in figure 5, when the thermal print head 21 is positioned at a certain angle α relative to the surface of a paper sheet 23, it is possible to arrange that the angle β at which a ribbon 22 is pulled away from the paper sheet 23 is large. Moreover, because the pressure of the thermal head 21 on the paper sheet 23 is concentrated at one point, it has been found that the print quality can be improved.

However, since the heat-generating element 13 of the thermal print head 21 inevitably approaches the side surface of the substrate 11 because the glass glaze member 12 is provided on the side surface of the thermal head substrate, the space for securing the common electrode 14 of the thermal print head 21 in position becomes narrower and therefore results in the disadvantages cited below.

(1) The current capacity of the common electrode 12 is made small. Consequently, when many dots are energized, a voltage drop phenomenon occurs thereby causing deterioration of the print density.

(2) If the said deterioration of the print density is to be prevented, the time division produced by a time division circuit must be adjusted, thereby lowering the speed and increasing the print cost due to the complication of the control system.

(3) When the common electrode 14 is used on the side surface and rear surface of the heat-resistant insulating substrate 11 shown in figure 3(b), the cost of manufacturing the head increases substantially.

(4) In the construction shown in figures 3(a) and (b), it is required to provide 200 to 300 μm for the distance between the side surface of the head and the edge surface of the glass glaze member 12. When the head is designed to produce a large number of dots, it is hard to bring the glass glaze member 12 close to the side surface. An attempt to solve this problem is disclosed in Japanese Laid-open Patent Application No. 132580/86. Figure 4 is a sectional view of the construction disclosed therein and the severity of the above-mentioned problems (1) to (4) is improved considerably by this construction which makes the current capacity of the common electrode 14 large by providing a common electrode 14 a part of which is disposed under the glass glaze member 12. However, it still has disadvantages in relation to the print speed and the current capacity of the common electrode.

According to the present invention, there is provided a thermal print head comprising:

- a heat resistant substrate;
- electrode means, at least one portion of which is disposed on the substrate;
- a glass member forming a ridge like protrusion disposed on said portion of said electrode means and adjacent an edge of the substrate; and

a heat generating element provided on said glass member, wherein the improvement lies in said glass member comprising a first lower layer of crystallised glass and an upper layer of non-crystallised glass.

Preferably, the various layers have different softening points.

Preferably, at least a part of the glass member is disposed between the said one portion of the electrode means and another portion or portions thereof.

The head may be provided with a passivation film which covers the said other portion or portions of the electrode means, and also covers a part of the heat generating element.

The said one portion of the electrode means may extend outwardly of another portion thereof which is in electrical contact therewith.

The invention is illustrated, merely by way of example, in the accompanying drawings, in which:-

Figure 1 is a sectional view of an embodiment of a thermal print head according to the present invention;

Figure 2(a) is a sectional plan view of the thermal print head shown in figure 1, figure 2(a) showing a first glass glaze layer after it has been heat treated;

Figure 2(b) shows the portion B of figure 2(a) on a larger scale, figure 2(b) showing the print position of a second glass glaze layer;

Figures 3(a) and (b) are sectional views of prior thermal print heads;

Figure 4 is a sectional view of another prior thermal print head; and

Figure 5 is a sectional view showing the relative positions of a head, a ribbon and a paper sheet of a thermal printer.

In figure 1 there is therefore shown an embodiment of a thermal print head according to the present invention comprising a heat-resistant insulating substrate which supports a glass member 2. The glass member 2 comprises glass glaze layers 2a, 2b formed of two kinds of glasses having different softening points,

each such layer being applied by a screen printing technique. A heat-generating element 3 is provided on the glass member 2.

A common electrode 4 is formed on the substrate 1 under the glass glaze layer 2a and is in electrical contact, by way of the interposed heat-generating element 3, with an upper thin film electrode 4a at the portion marked A. An independent electrode 5 is mounted on the heat-generating element 3, and a passivation film 6 covers the thin film electrode 4a, the independent electrode 5 and a part of the heat-generating element 3. The portion of the heat-generating element 3 between the thin film electrode 4a and the independent electrode 5 is disposed on the glass glaze layer 2b.

The thermal print head shown in figure 1 may be formed by the following steps.

Firstly, a metal paste comprising Au, Pt, or compounds thereof, is printed on the heat-resistant insulating substrate 1, the latter being formed of alumina or the like. It would be better for this metal paste, which is to form the common electrode 4, to be heated to as high a heat treatment temperature (i.e. a temperature at which it is heated) as possible. However, one reason why this has not been done until now, although it has been proposed, is that the heat treatment temperature of the glass glaze layer is higher than that of the metal paste. In the present invention, an Au paste having a heat treatment temperature of 870° to 880°C is used.

After Au paste has been heat treated, as shown in figure 2, the first layer of glass glaze 2a is printed. This glass glaze 2a is controlled so that it will be crystallized after the heat treatment. Metal and most non-crystallized glass have poor wettability, and this has the disadvantage that they can be easily separated from each other at the time of the heat treatment. This is the second reason why the above method cannot be used. However, by employing crystallized glass, this problem can be overcome. The crystallized glass, however has considerable surface roughness, and therefore it is not suitable for supporting the heat-generating element

3. Further, if the common electrode 4 (the heat treated metal paste film) is wide, the glass glaze layer 2a inevitably would also have to be wide. So, the main object of securing contact with the paper cannot be achieved. Accordingly, in this embodiment of the present invention, a non-crystallized glass layer 2b of less than 1.0mm in width is printed on the crystallized glass layer 2a, thereby providing the glass member 2 with the required surface smoothness and contact with the paper.

The glass glaze member 2 is formed by heat treating the first layer 2a and the second layer 2b at the same time. For example, this heat treatment may be performed at a temperature of $850^{\circ}\text{C} \pm 0^{\circ}\text{C}$ which is slightly lower than the heat treatment temperature of the metal paste. In this case, there will be good adhesion of the metal paste and the glass glaze member 2 constituted by the first layer 2a and the second layer 2b.

On the glass member 2 which has been formed on the substrate 1 by the above-mentioned method, the heat-generating element layer 3 and thereafter the electrode layers 4a, 5 are formed by using a vacuum thin film sputtering device etc. Then, by using general photolithographic technology, the formation of the heat-generating element 3 and the electrodes 4a, 5 is achieved, and finally the heat-resistant insulating passivation film 6 is formed by the vacuum thin film device.

The width and thickness of the common electrode 4 are determined in accordance with the dot density and with the number of dots of the thermal print head. For example, if the head has the standard 48 dots and 240 dpi (dots per inch) (94.5 dots per cm) for use in a serial type printer, the thickness of the common electrode 4 is designed to be 10μ , and the width thereof is 1.00mm. In the case of these design values, a voltage drop due to the electrode resistance does not occur even in full dot printing. In another example, if the head has the standard 960 dots and 240 dpi (94.5 dots per cm) for the 4 inches (10.16 cms) of a line type printer, the thickness of the common electrode 4 is 15μ and the width thereof is 5.0mm. In this case, no reduction in print density due to a voltage drop could be observed.

Further, in order to improve the edge effect, it is important to make the distance between the edge surface of the glass member 2 and the heat-resistant insulating substrate 11 as small as possible. It was found that it is desirable to make the distance between the edge surface of the glass glaze member 2 and that of the heat-resistant insulating substrate 1 not more than 0.1mm. When the thickness of the glass glaze member 2 is 50m, the distance between the edge surface of the glass glaze member 2 and that of the heat-resistant insulating substrate 1 is 0.1mm. Therefore, it is possible to incline the head 21 at an angle of about 10° relative to the paper sheet 23. Consequently, the print quality on rough paper can be improved considerably. If the said angle is less than 6° , an improved effect on rough paper in comparison with a known head is not obtained. It has been found that it is possible to reduce the cost of making the head of the present invention by 10% relative to the cost of making comparable known heads.

A print experiment was carried out using the thermal print head manufactured as mentioned above. In the experiment, a head having the standard 48 dots and 240 dpi (94.5 dots per cm) was used. In particular, the development of "tailing" (ie. blurring, or the production of breaks in the impression as a result of an overtransfer phenomenon) was investigated.

The result in comparison with a prior head (having the shape shown in figure 4) was as follows.

TABLE

Features	Present Invention	Prior Construction
1. Applied voltage	18.0V	18.0V
2. Pulse width	0.3ms	0.3ms
3. Applied energy	0.49mj	0.49mj
4. Limit pulse period	0.48ms	0.56ms

As shown in item 4 in the above Table, the limit pulse period, and consequently the limit period during which "tailing" could develop, was 15% less in the case of the present invention than in the case of the prior construction. Consequently, the printing speed is improved by 15%. It was also found that the cost of manufacturing a thermal head in accordance with the present invention was only 2% more than that of manufacturing one in which the glass glaze member did not have a plurality of layers.

As mentioned above, the present invention makes it possible to provide an improved head in which the print quality is greatly improved at a low cost. Further, the voltage drop due to the fact that many dots are energized at the same time, and the accompanying reduction of print density, can be solved completely. Accordingly, the speed of the head can be greatly improved.



CLAIMS

1. A thermal print head comprising:
a heat resistant substrate;
electrode means, at least one portion of which is disposed on the substrate;
a glass member forming a ridge like protrusion disposed on and overlapping
said portion of said electrode means and adjacent an edge of the substrate; and
a heat generating element provided on said glass member, wherein the
improvement lies in said glass member comprising a first lower layer of crystallised
glass and an upper layer of non-crystallised glass.
2. A thermal print head as claimed in claim 1 in which the various layers have
different softening points.
3. A thermal print head as claimed in claim 1 or 2 in which at least a part of
the glass member is disposed between the said one portion of the electrode means
and another portion or portions thereof.
4. A thermal print head as claimed in any one of claims 1 to 3 in which the
head is provided with a passivation film which covers the said other portion or
portions of the electrode means and also covers a part of the heat-generating
element.
5. A thermal print head as claimed in any preceding claim in which the said
one portion of the electrode means extends outwardly of another portion thereof
which is in electrical contact therewith.
6. A method of manufacturing a thermal printhead, as claimed in any one of
the preceding claims, said method comprising:
printing a metal paste on said heat-resistant substrate;
applying a heat treatment to said printed paste at a first temperature to form
said electrode means;



printing a non-crystalline layer of glass on said crystalline layer;
applying a second heat treatment at a second temperature lower than the first
temperature; and
forming said heat generating layer on said non-crystalline layer.

7. A thermal print head substantially as hereinbefore described with reference to
and as shown in figures 1 and 2 of the accompanying drawings.
