Development of the High Durability Overcoat for Thermal Printhead

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Abstract

The market for the thermal-type printer is expanding. The thermal printers are used in various environments, where the thermal printhead is exposed to year round temperature and humidity fluctuations. In these harsh environments, stronger corrosion resistance is required.

In this paper, we describe the new overcoat for the thermal printhead to achieve higher corrosion resistance. It is six times stronger than Kyocera's conventional ones. The overcoat for the thermal printhead has an important function as the prevention of corrosions. Generally, the thicker overcoat is used in order to enhance the corrosion resistance. However, this new overcoat enables to make it 15 percent thinner, despite the enhancement of durability to corrosion. Moreover, this new overcoat increases the energy efficiency and the printing quality.

The functions of the overcoat

First of all, we explain the overcoat for the thermal printhead. Figure 1 shows the cross section of the thermal printhead around heater. The overcoat is covering the electrode layer and the heater element. The overcoat has two important functions for the thermal printhead. First, it is to protect the heaters from mechanical abrasions by the media. The heaters for the thermal printhead contact with the media, when printing. If the overcoat isn't on the heaters, the heaters are rubbed by the media, which causes the thermal printhead to be worn out. Therefore, the overcoat is preferred to be thicker and harder material which has more abrasion resistance. Generally, the printhead life is in proportion to the overcoat thickness. However, the thick overcoat leads to decrease the energy efficiency and the print quality. It is discussed in the publication of conference paper available at [1]. Second, it is to prevent the heaters or the electrodes from corrosion. Printhead life usually ends when the overcoat is worn out. However, the thermal printhead can be damaged by corrosion of the heaters and the electrodes before the overcoat is worn out. In order to use the thermal printhead until the overcoat is worn out, it is necessary for the overcoat layer to seal the heaters and the electrodes completely. In this way, the overcoat has very important functions for the thermal printhead in terms of the printhead life, energy efficiency and print quality.

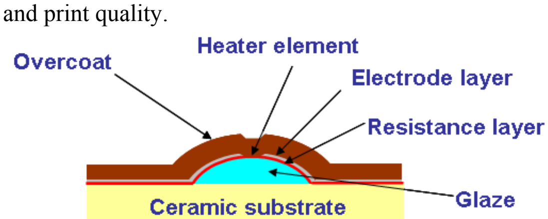

***Figure 1**. Cross section of the thermal printhead*

KC-50 series overcoat

Thermal printers are now used all over the world. The thermal printers are often used in the harsh environments, where corrosive material is suspending around the thermal printers. In this background, the thermal printhead with stronger corrosion resistance is required.

Generally, the thicker overcoat is used in order to enhance the corrosion resistance. The corrosion occurs because the electrode reacts to corrosive material, alkaline ion and chlorine ion, through the overcoat. When the protective layer is thick, it is difficult for the corrosive material to reach to the heaters or the electrodes though the overcoat. So the corrosion resistance is controlled by the overcoat thickness. However, this method has a weak point that increasing the overcoat thickness causes the print quality to be degraded remarkably. That is because heat flow form the heater to the surface of the overcoat is made to be worse by thickening the overcoat. Moreover, the thick layer causes low productivity. We need to extend the processing time of the deposition to increase the thickness of the overcoat. In terms of total characteristics of the thermal printhead, it is required to enhance the corrosion resistance without thickening the overcoat.

In this paper, we describe the new overcoat. We call the new overcoat KC-50 series. It enables to enhance the corrosion resistance without increasing the thickness of the overcoat. The new overcoat is 15 percent thinner than the conventional one. And we can improve not only corrosion resistance but also the energy efficiency and the print quality. We need to consider the abrasion resistance of the new overcoat. Usually, thin overcoat abrasion resistance is lower than thick one. However, abrasion resistance of this new overcoat is equivalent as the conventional one. Typically, overcoat has dual layer. Top layer has abrasion resistance and bottom layer has corrosion resistance. In this KC-50 series overcoat, the bottom layer is modified to higher corrosion resistance from conventional one. And, same top layer is used. This is the reason why abrasion resistance is no difference from conventional overcoat.

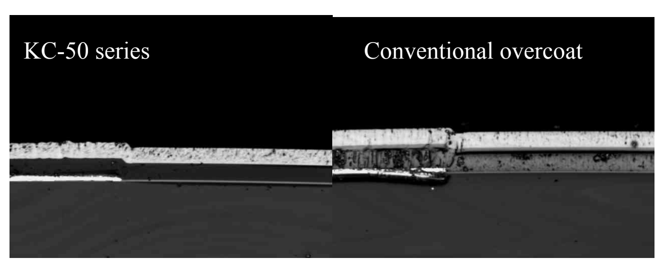

***Figure 2**. Laser Microscope images*

Laser microscope images of the new overcoat and the conventional overcoat are shown in the figure 2. KC-50 series improves the bottom layer of the conventional.

Evaluation method of corrosion resistance

In this section, we explain the method of the corrosion evaluation. We show the image of the method in figure 3. First, we prepared 5%NaOH alkaline water solution in the container and immersed a thermal printhead and applied +24V between VH and GND in the solution. We counted corroded dots of the printhead every some minutes and calculated "corroded dot ratio", which is given by a below equation.

(Corroded dot ratio) = (corroded dots) / (total dots of printhead)

In this test, total dots of the printhead are 432 dots. The condition of this accelerated test is 3,500 times harsher than a typical environment (20℃,65 percent relative humidity, by JIS difinition).

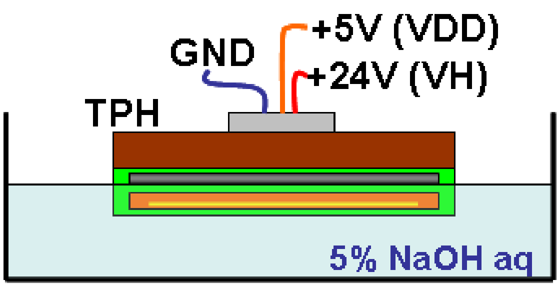

***Figure 3**. The method of the corrosion evaluation*

Test result

Figure 4 shows the result of the above test. In figure 4, the vertical axis is corroded dot ratio and the horizontal axis is immersion time. Three lines are the results of KC-50 series, the conventional overcoat and 1.5 times thicker overcoat than the conventional overcoat. The 1.5 times thicker overcoat is improved in corrosion resistance compared to the conventional overcoat. We find that corrosion resistance is improved by increasing the overcoat thickness. On the other hand, the result of the new overcoat, KC50 series, is further improved. It takes six times longer for KC-50 series to reach the same level of corrosion as the conventional overcoat. This improvement is given by three factors. First, it is the proper condition of thin film deposition. We get the best sealing characteristics by deposition with the optimized condition. Second, it is material. The new material generates very few defects by the thin film deposition process. Third, it is the processing time for the deposition. The processing time is shortened by decreasing the overcoat thickness. That reduces defects in the layer which causes corrosion. The higher corrosion resistance of the new overcoat is achieved by the three factors.

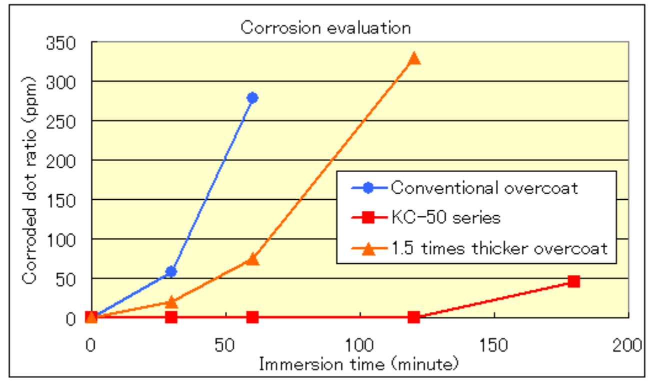

***Figure 4**. The evaluation result of the corrosion resistance*

Improved bar code print quality

In this section, we discuss bar code quality printed by KC-50 series printhead. The print quality is affected by the total structure of thermal printhead. The overcoat thickness is one of the key factors for the print quality. Quality standards in which the print quality is rated in five grades (A, B, C, D, F) based on "ANSI X3.182" Bar Code Print Quality Guideline. A to F is classified by a value(0.0～4.0) of reading grade which is given by the bar code reader. Reading Grade is defined by the print quality of the bar code. A to D indicate readable grades and F indicates unreadable grade. In the table 1, we show how to classify reading grade to Grade A～F. Figure 5 shows the relation between reading grade and print speed. Applied energy is 0.71W/dot and two level of history control method is used to optimize the print quality. Regular thermal paper for barcode application is used as the print media. In the figure, we can't find any differences between three overcoats, when print speed is slow. While when print speed is high, the difference appears.

Usually, the bar cord quality will be degraded when print speed becomes higher. However the print quality of the new overcoat maintains higher grade than the conventional overcoat with high speed printing. For example, the grade of the new overcoat is B at 356 mm/sec compared to the conventional with Grade C. While the 1.5 times thicker overcoat degrade the barcode quality. We find that the overcoat thickness makes an important effect on the bar code quality.

In figure 6, we show print samples of character "KYOCERA" and the bar code, which is printed by three kinds of overcoat samples which are KC-50 series, the conventional overcoat and the 1.5 times thicker overcoat. Print speed is 16ips (=406 mm/sec) and applied energy is 0.71W/dot and two lines history control is used. In figure 5, when print speed is 16ips, KC-50 series is grade C, the conventional overcoat is Grade D and the 1.5 times thicker overcoat is grade F. The bar code quality depends on three main factors. First one is the fluctuation of the space between bars. Second one is the variation of width of bar. Third one is the optical density of bras. All those factors are related with the thickness of the overcoat. Thin overcoat affects those factors better. This is the reason why higher grade barcode quality with KC-50 series than the conventional overcoat even high speed printing.

Table1. Reading grade

	Reading Grade	Success rate of reading
Grade A	3.5 ~ 4.0	87.5~ 100%
Grade B	2.5 ~ 3.4	62.5~ 87.5%
Grade C	1.5~ 2.4	37.5~ 62.5%
Grade D	0.5~ 1.4	12.5~ 37.5
Grade F	0.0~ 0.4	12.5%below

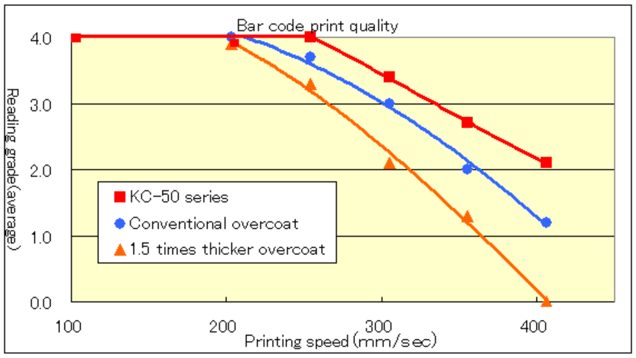

***Figure 5**. Bar code print quality*

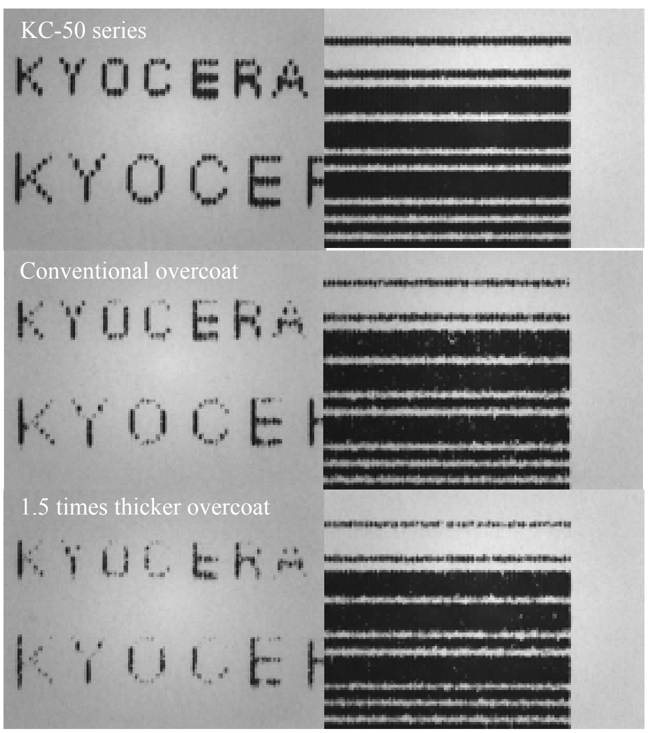

Figure6. Print samples of character "KYOCERA" and bar code

Conclusion

In this paper, we described our new overcoat, KC-50 series. Stronger corrosion resistance is required in the thermal printer market recently. Generally, we make the overcoat layer thicker in order to enhance the corrosion resistance. However, KC-50 series has six times greater corrosion resistance than the conventional overcoat, even though it is 15 percent thinner than conventional one. The new overcoat thickness results in the high energy efficiency and print quality. Therefore, this new overcoat can keep the higher grade print quality than the conventional overcoat even high speed printing. Moreover, the new overcoat thickness makes productivity improved, which gives us short takt time and material-saving.

References

[1] Kazuyoshi Sakamoto, Development of high efficiency thermal printhead (IS&T, Austin, TX, 2010) pg. 701

Author Biography

Yoshihiko Fujiwara graduated from Kyushu University in 2005 with a degree in Physics. He received a Masters Degree in Science from Kyushu University in 2007. His major was Condensed Matter Physics. He joined Kyocera Corporation in 2007. Presently he works for thermal printhead wafer process development.

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