Slipping Stability Improvement in Thermal Dye Transfer Printing System

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Abstract

Thermal dye transfer printing method has often been adopted in the field where high-quality image is required for the on-the-spot output due to the advantages such as in gradation expression, output speed, and system stability. In this method, further system stability and maintenance-free operation are required in the deployment of minilabs where larger volume of prints with higher speed is essential from now on. To realize these requirements, with an objective to improve slipping stability in the thermal dye transfer printing system, a new heat-resistant slipping layer of the ink ribbon has been designed. This report discusses improvement of friction stability between thermal printhead and heat-resistant slipping layer, and substantial decrease of abrasion-resistance against thermal printhead protective layer.

Introduction

Recent years have seen a remarkable performance improvement in the digital printing devices. Along with it, the needs for outputting high resolution prints and large volume data are daily increasing. Thermal dye transfer method, among many output and printing methods, has been adopted in the field where the high quality image is required for the on-the-spot output due to the advantages such as in output speed, system stability and gradation expression. Thermal dye transfer printing system, as a result of 20 years of continued development, is now widely used for many applications.

Especially during the sticker print boom in the 1990's, the thermal dye transfer method was preferred and adopted and we saw the cognizance degree of the method rising so rapidly. Today it is often used as a powerful print means for the recording media used by the digital camera and the cellular phone camera at various locations such as at the kiosk terminal, in the store and at home.

This report introduces a heat-resistant slipping layer of the ink ribbon which was newly developed with an objective to further improve slipping stability of the thermal dye transfer printing system.

Heat-Resistant Slipping Layer

For securing heat resistance and slipping stability, the heat-resistant slipping layer is coated on the side of the ribbon that comes in contact with the thermal printhead (Figure 1). The heat resistance and the slipping stability are the substantial roles in the component pieces of the media because they directly influence the printing quality and the system stability. Furthermore, other than the primary role of heat-resistant slipping, from the point of maintenance-free operation and ribbon preservability, the heat-resistant slipping layer is required to act as the thermal printhead cleaner and dye transfer prevention from the dye layer.

Heat-resistant slipping layer is composed of resin binders, lubricants, and fillers out of which the resin binders facilitate heat resistance and dye transfer prevention, the lubricants facilitate slippage, and the fillers facilitate maintenance-free cleaning.

A heat-resistant slipping layer has been newly designed in order to sustain the stable slippage of the donor ribbon at all times regardless of the kind of the printer and to enhance the print quality reliability for the thermal dye transfer recording system.

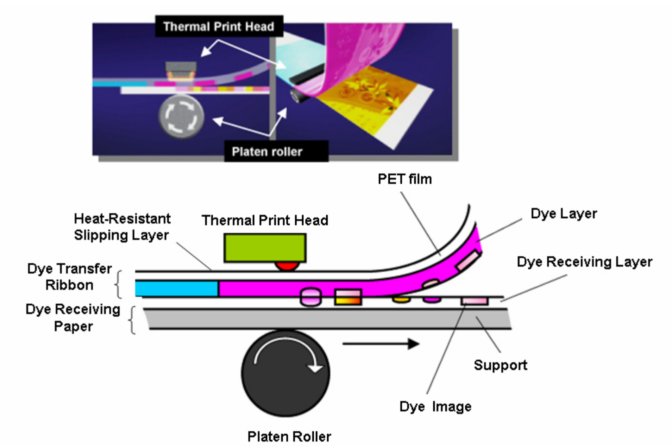

Figure 1*. Schematic view of thermal dye transfer printing*

Friction Force between Printhead and Heat-Resistant Slipping Layer

Slipping stability of the heat-resistant slipping layer depends on the friction force between the printhead and the heat-resistant slipping layer. It is an important factor in particular for the heat-resistant slipping layer to give low friction force in all energy ranges from low energy range to high energy range as well as to give less friction force change against energy change since the thermal dye transfer printing method expresses the gradation by changing the printing energy [1].

In this development, in order to assess the friction force between the printhead and the heat-resistant layer, an exclusive apparatus was built to measure by the load cell the load applied to the thermal printhead during printing and printed the continuous tone pattern for the assessment (printing speed 1.0msec/line).

The friction force chart of the previous heat-resistant slipping layer A and B are shown in Figures 2 & 3. The heat-resistant slipping layer A shows excellent friction force stability in the high density area, however, rising friction force is seen in the middle tones. This phenomenon is due to insufficient lubricant that covers the temperature range of the middle tones. In this heat-resistant slipping layer, certain cases have been confirmed where the printing wrinkle is generated in the images that contain a lot of middle tones. On the other hand, the heat-resistant slipping layer B shows the friction force rising rapidly in the high density area, although overall friction force is controlled at a lower range than that of A. These will lead us to think that there is a possibility of a risk generating printing wrinkle that has a lot of high density area in the heat-resistant slipping layer B and there is concern generating printhead debris after a long-run printing.

From these findings, it can be said that it is extremely important to stabilize the friction force in all printing energy range. Especially, the friction force stability in the high density area needs special attention from now on because there is a tendency of increasing printing energy along with faster printer speed. Having been put under such circumstances, the new heat-resistant slipping layer was developed.

Friction force performance chart of the newly developed heat-resistant slipping layer C is shown in Figure 4. Heat-resistant slipping layer C shows smooth friction force performance in all printing energy range, and the high density area is properly stabilized as well. This stability is achieved by having plural solid lubricants each expressing its own slippage at different temperature range.

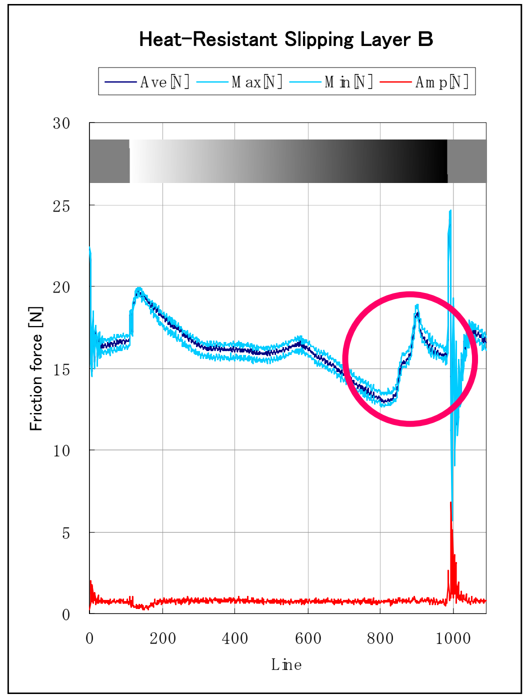

***Figure 3**. Friction force chart (Heat-resistant slipping layer B)*

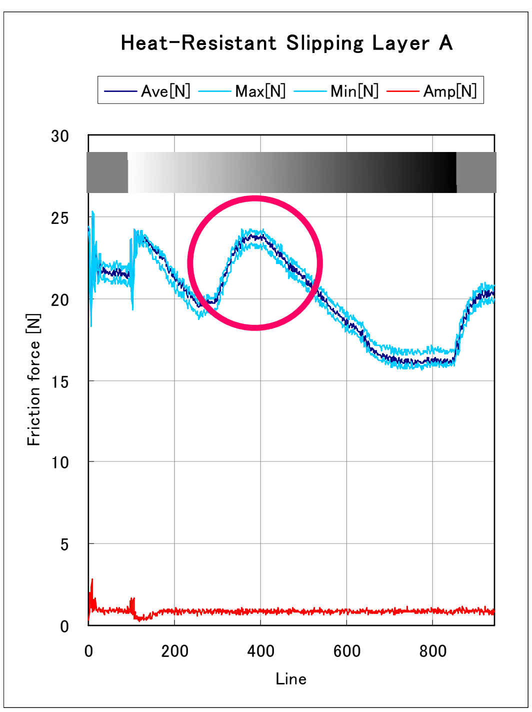

***Figure 2**. Friction force chart (Heat-resistant slipping layer A)*

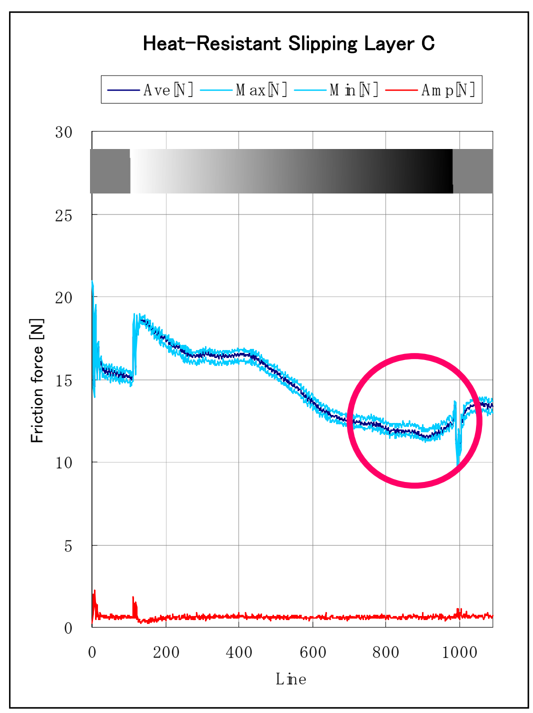

***Figure 4**. Friction force chart (Heat-resistant slipping layer C)*

Thermal Printhead Durability

Heat-resistant slipping layer has two important performance properties. One is a low abrasion property and the other is the cleaning property.

In the thermal dye transfer recording method, the thermal printhead moves forward touching the heat-resistant slipping layer. If a large amount of printing is put through, the outermost protective layer of the thermal printhead wears out (See Figure 5). The headwear progression gives changes to the contact conditions of the thermal printhead and the platen roller generating printing defects such as wrinkles and scratches. Also in the case where cleaning performance is insufficient, debris of the heat-resistant slipping layer will stick to the neighborhood of the heating element of the thermal printhead causing defects such as density decrease and printing scratches. When the printing quality deteriorates, it will eventually be necessary to replace the printhead whereby repeated replacements will invite operation cost increase. For the recent store use printers, in order to increase the production of the prints per hour, printing speed has been increased and printing energy has been raised. Because of these there is a tendency of faster headwear progression and debris sticking to the printhead. From the point of printhead life duration improvement, material selection for the heat-resistant slipping layer has been carefully conducted taking into consideration of the required friction-free performance.

An assessment of the thermal printhead abrasion-resistance and cleaning test was carried out by long-run printing tests on a printer bought at a regular retail store and pre-, post- thermal head conditions were observed. As for the thermal printhead protective layer, SiON type which is widely used in thermal dye transfer method printers has been used. Figure 6 shows the graph of thermal printhead protective layer abrasion extent against the number of prints printed. The result is that the newly developed heat-resistant slipping layer C successfully reduced the abrasion extent of the thermal printhead protective layer by one-third compared to the previous heat-resistant slipping layer A. Figure 7 & 8 show enlarged pictures of what was observed by microscope of a surrounding area of the thermal printhead heating element pre-, post- long-run operation test for the heat-resistant slipping layer C. It has been confirmed that even after 40,000 prints printed (black printed area) there was no debris stuck on the heating element to show sufficient cleaning had been done. Furthermore, if SiC type which excels in durability compared to SiON type is used, we can expect increased printhead durability.

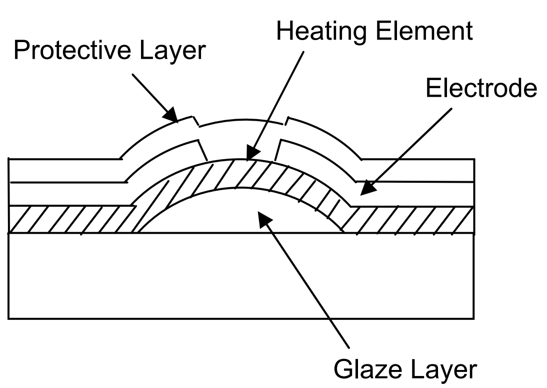

***Figure 5**. Schematic diagram of thermal printhead*

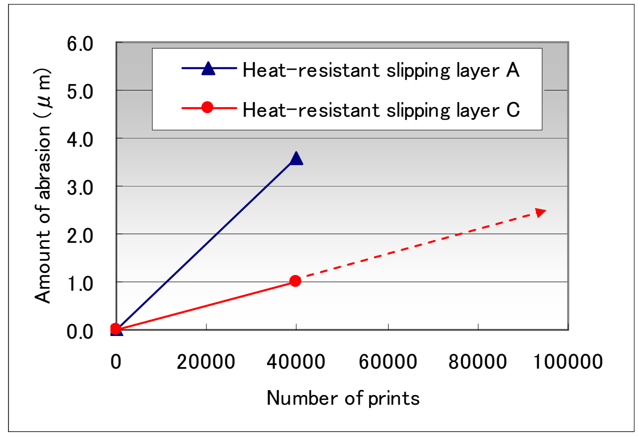

***Figure 6**. Amount of abrasion of thermal printhead protective layer vs. number of prints*

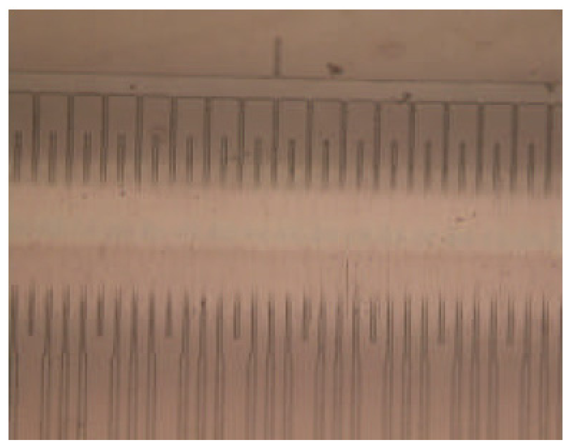

***Figure 7**. Pre-test thermal printhead heating element surface*

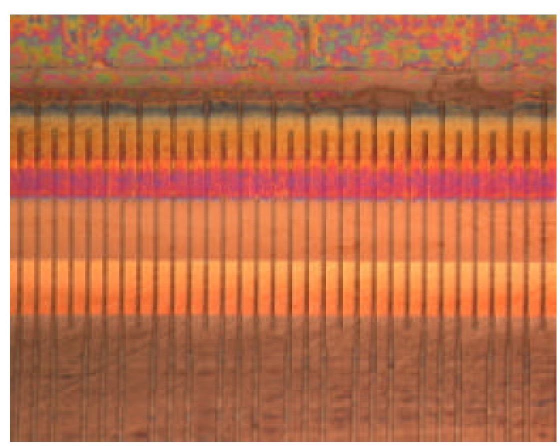

***Figure 8**. Post-40,000 prints thermal printhead heating element surface (black printed area)*

Conclusions

With an objective to further improve slipping stability of the thermal dye transfer printing system, a new heat-resistant slipping layer of the ink ribbon has been designed. As a result, improvement of friction force stability between thermal printhead and heat-resistant slipping layer as well as substantial abrasion decrease against the thermal printhead protective layer have been successfully accomplished. It is believed that the development of this heat-resistant slipping layer achieves the high durability of the printhead required in a large amount of print age of the future and can greatly contribute to the decrease of the operation running cost.

References

[1] D. Fukui, “New Thermal Dye Transfer Media for Digital Photo Usage”, IS&T’s NIP20: International Conference on Digital Printing Technologies, pg. 980 (2004).

Author Biography

Daisuke Fukui received his Bachelor of Engineering in material science and technology from the Chiba University (1994) and his Master of Engineering in material science and technology from Chiba University (1996). Since then he has worked at Dai Nippon Printing Co., LTD. Information media Laboratory in Okayama, Japan. His work has focused on the development of thermal dye transfer media.