New Thermal Dye Transfer Media for Digital Photo Usage

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Abstract

The thermal dye transfer method capable of printing beautiful photo-quality images in a simple and quick manner is attracting more and more attention as a digital photo output system because of its dry process, maintenance-free feature and the easiness of downsizing the printer system. We have been working on the various issues such as higher sensitivity, travel stability of the ink ribbon and improvement of photo quality functions, all of which are essential as a media for digital photo printers.

Higher sensitivity of the dye transfer ribbon has been accomplished by increasing the dye transfer ratio, not by the increase of the amount of dye. Moreover, further improvement of heat resistant layer of the transfer film and travel stability of the ink ribbon as well as smaller amount of abrasion of the thermal head protection layer have contributed to enhance the system's maintenance free feature. Thus, by our efforts of getting better glossiness of print and also better color reproduction of neutral black, we have succeeded in developing a new thermal dye transfer media having a higher photo quality.

Introduction

Following the transition period from silver-halide to digital, the full-scale digital imaging business has only just begun. Under this circumstance, our biggest concern is who will be widely recognized as popular media to handle printing from digital cameras. As possible media, we can name homes, DPE shops, convenience stores, camera and appliance shops, photo-kiosk terminals, internet printing or the like. Particularly in the field of home-use, besides printing via PC, the photo printers capable of direct printing from digital cameras as well as portable/mobile type photo printers are becoming popular and many products of these types have already been introduced to the market. Furthermore, because of increased needs of users who want to see pictures shortly after shooting, the instant printing service at photo-kiosk terminals or photo shops are also becoming remarkably popular.

The methods of printin these digital images include thermal dye transfer method, silver-halide method, ink-jet method, light-fixing thermal method or the like. Among them, the thermal dye transfer method is widely recognized now as a method capable of printing beautiful photo-quality images in a simple and quick manner. However, for the better future of digital photo printers, the following additional functions must be provided:

- Higher throughput (for business use)
- Electricity saving (for home-use)
- Higher glossiness of print
- Improved maintenance- free feature

In view of the above points, we are glad to introduce a new thermal dye transfer media having a higher quality as digital photo media with its improved sensitivity of dye transfer ribbon, improved traveling performance and improved photo quality functions.

Higher Sensitivity of Dye Transfer Ribbon

As shown in Fig. 1, the dye transfer ribbon generally has a composition wherein the adhesive layer is provided between the film support and the dye layer. The adhesive layer is required to have functions such as excellent adhesion to both film support and adhesive layer and low affinity to dyes.

Dye Transfer Ribbon

Heat Resistant Layer
PET support
Adhesive Layer
Dye Layer

Figure 1. Composition of dye transfer ribbon.

In the thermal dye transfer method, dye is transferred from the dye layer to the receiving layer after the back surface of the dye layer is heated with the heat of thermal

head while the current adhesive layer allows certain amount of dye to be transferred to the adhesive layer too during printing (Fig. 2). Thus, in the current adhesive layer, efficient dye diffusion is retarded because of reduced amount of dye transferred to the receiving layer.

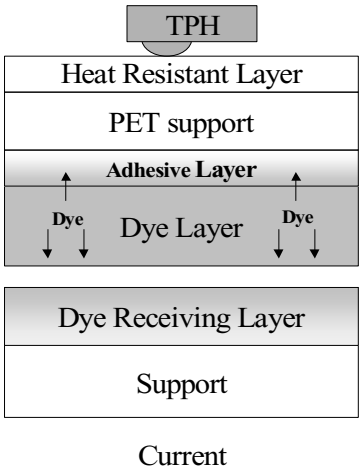

Figure 2. Schematic view of dye diffusion (current media).

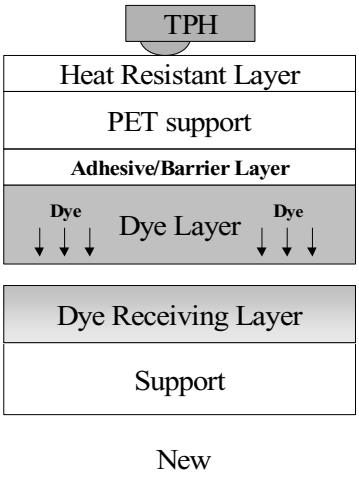

Figure 3. Schematic view of dye diffusion (new media).

In order to improve this dye transfer ratio, we have developed a new adhesive/barrier layer with a material having both barrier property and adhesion property (Fig. 3). As a result, we have succeeded in improving the dye transfer ratio by about 25% as compared with the current layer, wherein dye transfer ratio is calculated by absorbency of dye transfer ribbon before and after printing (Fig. 4).

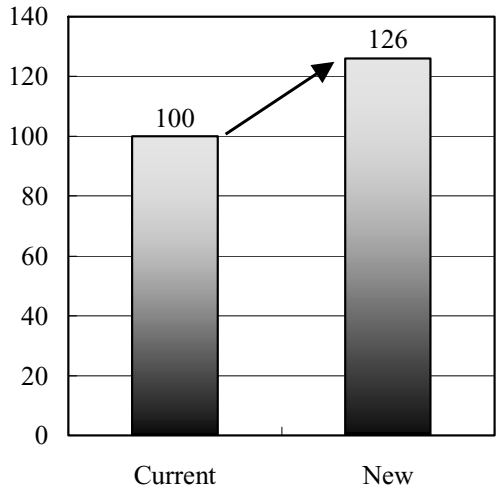

Figure 4. Comparison of the dye transfer ratio. (as compared with the current media:100.)

Thus, the new thermal dye transfer media designed so that the current adhesive layer also has a new barrier layer function makes it possible as an effect of better dye transfer ratio that the sensitivity at the time of printing is improved by about 10% as compared with the current layer even when the same amount of dye is used (Fig. 5). With this new thermal dye transfer media, we are able to contribute to the improvement of throughput of high-speed printers and also electricity saving of battery-operated mobile photo printers, both of which are widely used at photo-kiosk terminals, etc.

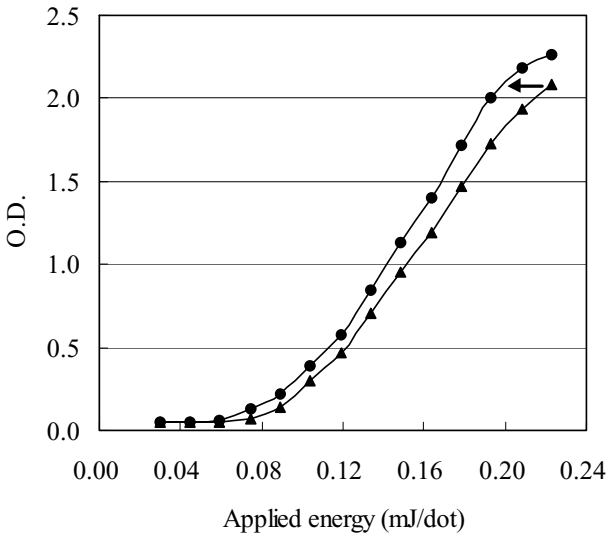

Figure 5. Effect of enhanced sensitivity of media. •: New ▲: Current.

Improvement of Traveling Performance

On the other side of the dye layer of the ink ribbon, a heat resistant layer is provided so that the ink ribbon could resist high temperatures during thermal printing and thereby the traveling performance is improved (Fig. 1). The heat resistant layer having a direct contact with the thermal head is one of the most important media components because of its direct impact on printing quality. We have developed a new heat resistant layer having an improved slippage with the thermal head in order to maintain stable traveling performance, regardless of the type of printers, at all times and thus enhance users' trust in printing quality.

Figure 6 shows a frictional force behavior when the continuous tone pattern is printed by using the new media. It will be understood from the figure that because of smooth friction behavior and narrower fluctuation range of friction within the entire printing energy range, stable traveling performance is well maintained. Moreover, friction force during printing or not, is also reduced by about 20% as compared with the current media and as a result the amount of abrasion of thermal head protection layer is also reduced to 1/2 ~ 1/3. This helps to substantially ease replacing requirements of thermal heads and thereby improve maintenance free feature at the places such as photo-kiosk terminals.

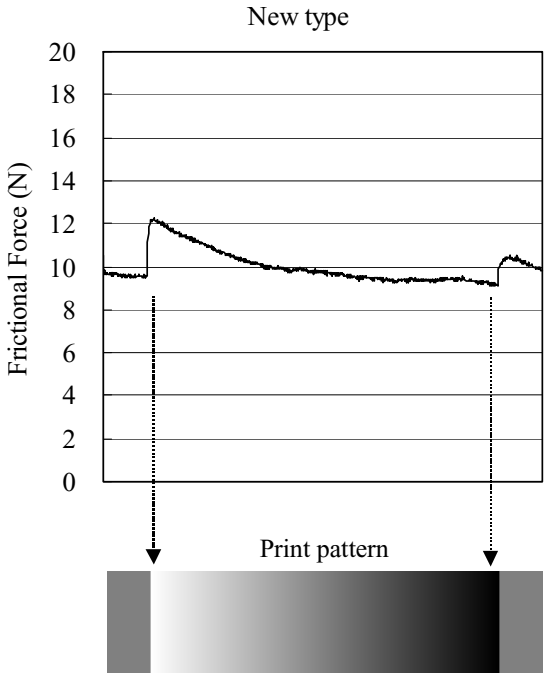

Figure 6. Frictional force behavior when the continuous tone pattern is printed by using the new media.

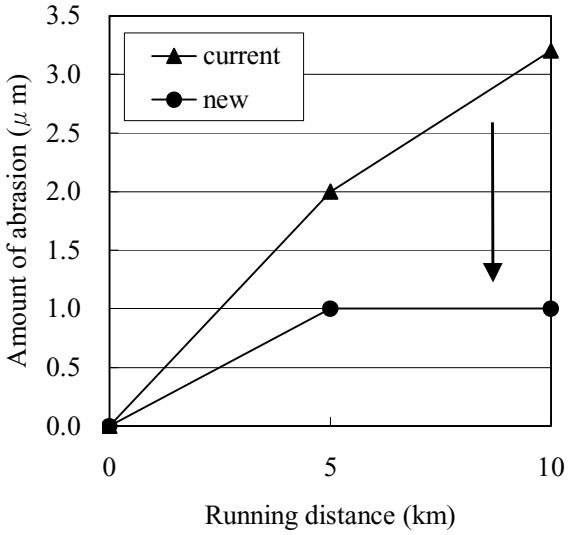

Figure 7. Amount of abrasion of thermal head protection layer vs. running distance.

Improvement of Photo Quality

Higher Glossiness of Print

Higher glossiness of print is one of the elements required for photo quality printing. In the thermal dye transfer method having a thermal printing properties, the high temperature heating from the thermal head particularly at the high density portion causes the receiving layer to have a rough surface with less glossiness. This effect could be removed to some extent by transferring the protection layer after image forming and smoothing the rough surface of the receiving layer.[1] However, even with these improvements, its photo quality is still not sufficient enough to be leveled with that of silver-halide method and therefore quality having more glossiness is required.

In order to improve the print's glossiness, the surface of the protection layer after the transfer must be kept smoother, which inevitably makes control of surface roughness of the transfer interface of the protection layer a critical point.

We have developed a new media having about 13% more surface glossiness than the current media, by designing to control surface roughness of this transfer interface to be smoother (Fig. 8).

Reproduction of Neutral Black

Reproduction of black color close to neutral black is helpful to improve photo quality printing. We have designed the media so that it reproduces the neutral black by maintaining well-balanced dye staff of each color without lowering the maximum density of composition black. As a result, we can see in the new media that the color reproduction region of composition black color (a*b* diagram) has moved to the vicinity of zero point as shown in Fig. 9.

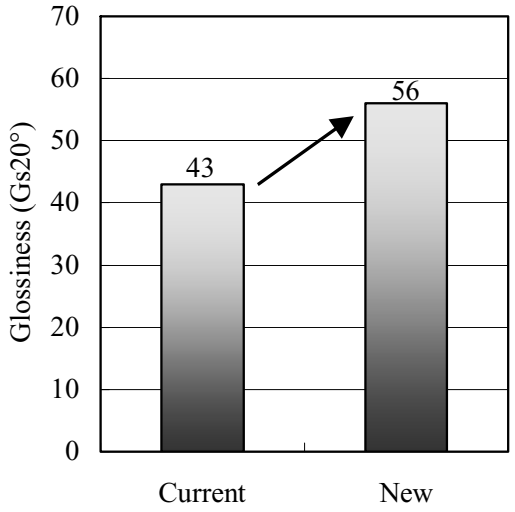

Figure 8. Glossiness of print.

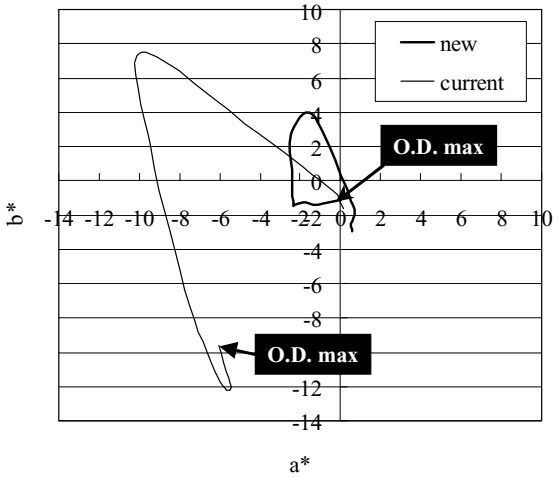

Figure 9. Composition Bk gamut.

Conclusion

We have developed a new thermal dye transfer media having advanced functions as digital photo media. The dye transfer ribbon with higher sensitivity has been introduced with the development of a new barrier/adhesive layer for an improved dye transfer ratio. Further improvement of heat resistant layer has also helps to raise user's trust in the stable output of printers. In addition, photo quality has been remarkably improved by higher glossiness and reproduction of neutral black. We are confident that the new thermal dye transfer media with advanced functions as introduced above will greatly contribute to the further spread of digital photography.

References

1. H. Saito, International Conference on Digital Printing Technologies, 251 (1999).

Biography

Daisuke Fukui attended Chiba University in Japan (majored in chemistry), 1992-1996. From 1996-2004 he has been with Dai Nippon Printing Co., Ltd. Information media Laboratory (research & development of thermal dye transfer media.)