Image Stability of Printpix Paper

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Abstract

An advanced type of TA (Thermo Autochrome) paper with high image stability, named "Printpix Paper" has been released. The light stability, the dark stability and the stability with respect to gases were studied to understand the image stability of the Printpix paper. The light stability under normal display conditions was predicted by means of an accelerated light test which utilized a fluorescent light and a xenon arc light. The dark stability at room temperature was predicted by an accelerated thermal test based on Arrhenius methodology. The amount of image fading that actually occurred indoors with regard to TA paper was also confirmed by the test. It showed that the amount of image fading on TA paper was not influenced by gases such as ozone, and the result of the accelerated light test corresponded to the actual image fading which occurred indoors. In this paper the authors will demonstrate that the image stability of the Printpix paper has been remarkably improved in comparison to previous TA paper and the practical image stability of the Printpix paper is satisfactory.

Introduction

The Printpix paper is an advanced type of "TA" direct thermal full color recording paper. This environmentally friendly print system creates high quality continuous tone full color prints that requires no inks, toners or ribbons, thus minimizing waste. In addition, the print is obtained by a complete drying single-sheet process, and the printer can be relied upon due to the simplicity of its mechanisms.[1]

For the past couple of years various kinds of digital prints have come to be used widely in the output of digital still camera images. Therefore, the practical image stability for the photo-usage is required for these digital prints. The image stability of the Printpix paper will be studied, and shown to be a significant improvement on previous TA paper.

Mechanism of Image Formation

A simplified cross-sectional view of the Printpix paper is shown in Figure 1. The basic structure of the Printpix paper is as follows. The paper has an outermost heat-resistant protective layer and three color forming layers: a yellow color forming layer, a magenta color forming layer and an innermost cyan color forming layer. The yellow and the magenta color images were formed by an azo dye, and the cyan color image was formed by a leuco dye within the microcapsule in each color forming layer.

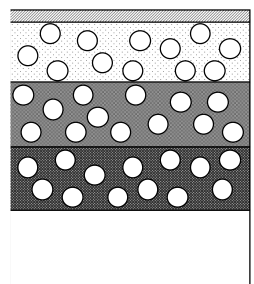

Figure 1. Simplified cross-sectional view of Printpix paper.

A full color print is obtained in a five-step printing process listed below.
1. Yellow color forming with low levels of thermal energy.
2. Yellow layer fixing with 420nm ultraviolet exposure.
3. Magenta color forming with mid-range levels of thermal energy.
4. Magenta layer fixing with 365nm ultraviolet exposure.
5. Cyan color forming with high levels of thermal energy.

Evaluation of Image Stability

Light Stability

An accelerated light stability test at 27klux fluorescent light was executed for up to 640 hours to compare the Printpix paper and the previous TA paper. The predicted light stability of the image fading and the stain increase are shown in Figure 2, on the assumption that an average ambient illuminance is 500lux for 12 hours a day. With this result, it was found that the image fading and the stain increase of the Printpix paper have been improved. The improvement in images in the magenta layer was particularly remarkable.

As verification of the reliability of the prediction from an accelerated light test, the result corresponded to the actual image fading which occurred indoors with previous TA paper. Figure 3 shows the result of image fading displayed under the following conditions.

(1) Average illuminance 600lux fluorescent light, 10 hours a day, exposed for up to 2 years.
(2) 27klux fluorescent light, exposed for up to 240 hours.

The results of both conditions were almost corresponding excluding little difference on the yellow image fading. Therefore, the reliability of the prediction from an accelerated light stability test on TA paper was verified.

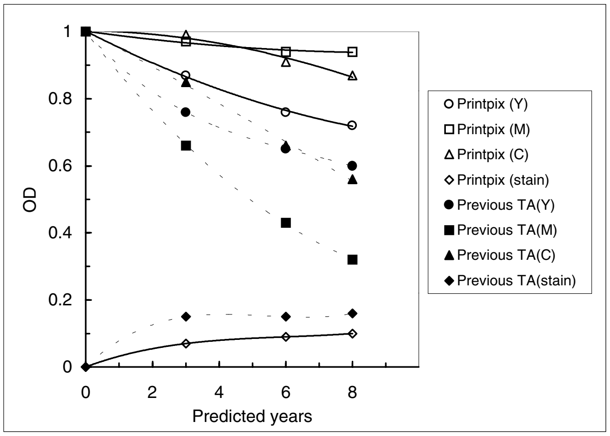

Figure 2. Predicted light stability at 27klux fluorescent light.

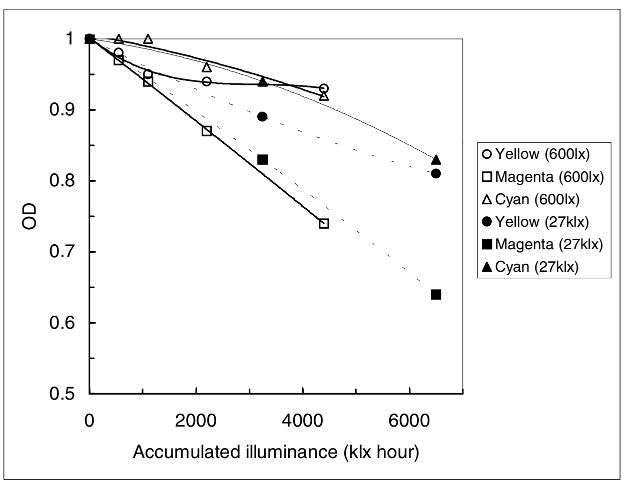

Figure 3. Light fading of the previous product of TA paper at 600lux and 27klux fluorescent light.

The comparison of the image fading to other digital print systems was also studied. Two types of D2T2 prints with overcoating (A, B), three types of dye-based inkjet prints with porous receiver (A, B) and swellable receiver (C) were compared to the Prinpix paper in Figure 4. In this test, 85 klux xenon arc light with a Pyrex/soda lime filter was exposed for 267 hours, (The light exposure cycle consisted of 3.8hour-light and 1-hour darkness.) corresponding to 10 years on the assumption that an average illuminance is 500lux for 12 hours a day.

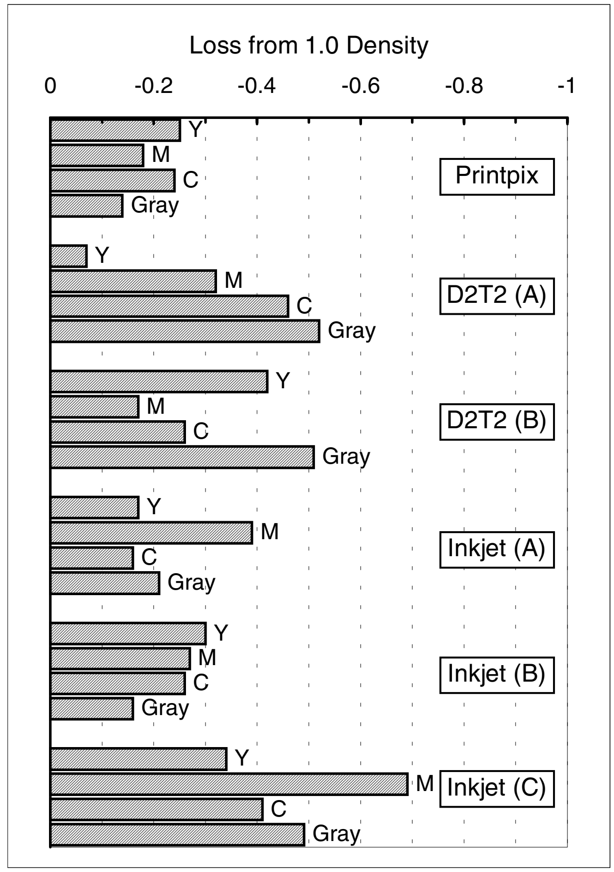

Figure 4. Light fading at 85klux xenon light. (corresponding to 10 years , assumed at 500lux for 12 hours a day)

Dark Stability

The dark stability at room temperature was predicted by an accelerated thermal test based on the Arrhenius methodology. The reliability of the prediction from an accelerated test for the TA paper has been verified in a previous report.[2] The temperature and the relative humidity of test conditions were 70, 60, 50 and 45°C, 70%R.H. The image fading and the stain increase at 70°C, 70%R.H. and 50°C, 70%R.H. is shown in Figure 5 and Figure 6 respectively. The density of the cyan image decreased, and the stain increased in accelerated thermal tests. However, the density of the yellow and the magenta image hardly decreased under these test conditions.

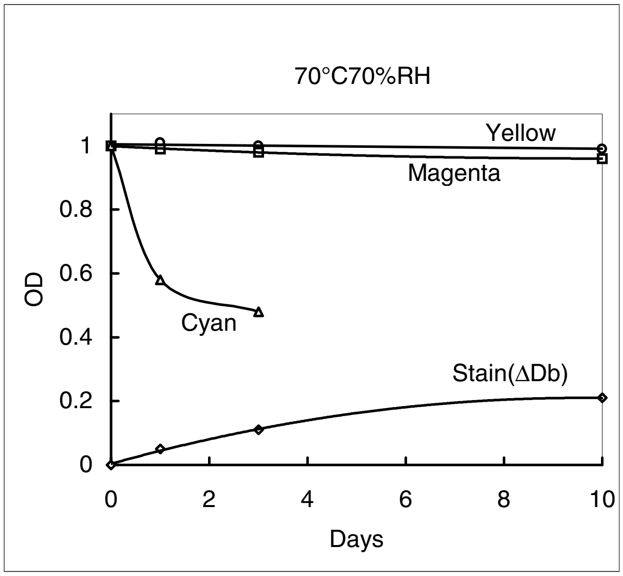

Figure 5. Image fading and stain increase at 70°C 70%R.H.

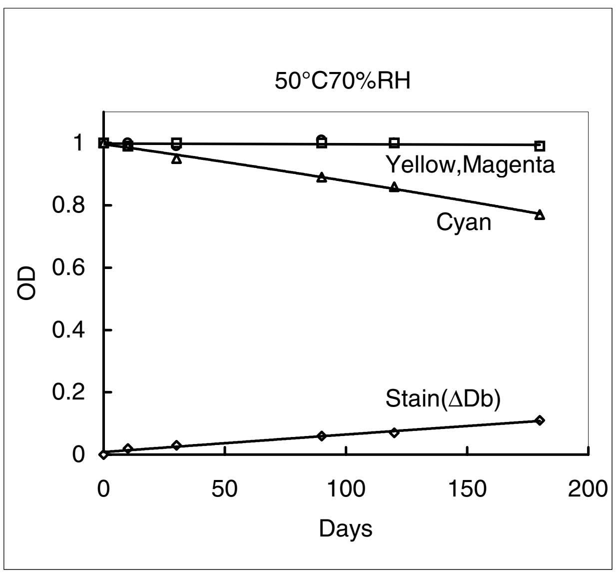

Figure 6. Image fading and stain increase at 50°C 70%R.H.

The cyan image fading and the stain increase was predicted by Arrhenius plots shown in Figure 7 and Figure 8 respectively. The predictions relating to the dark stability on the prototype of the Printpix paper at 25°C, 70%R.H. is shown in Figure 9. The product is currently being evaluated, as a long test time is required to confirm the result of the prediction.

Stability with Respect to Gases

The image fading with respect to the ozone is a crucial problem with the porous type of inkjet print. Figure 10 shows that no discoloration was observed on the Printpix paper after an accelerated ozone stability test at 2.5ppm 60 hours, because the dye of the image is protected within the microcapsule and the outermost protective layer.

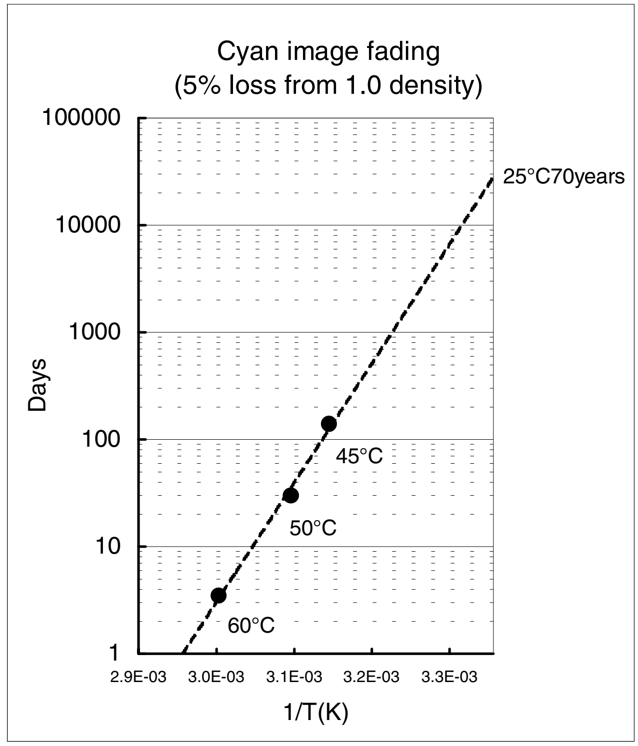

Figure 7. Arrhenius plot of cyan image fading.

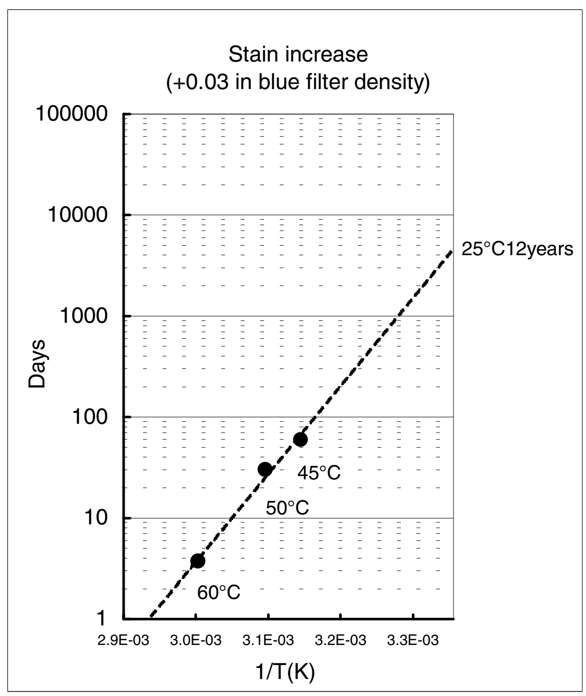

Figure 8. Arrhenius plot of stain increase.

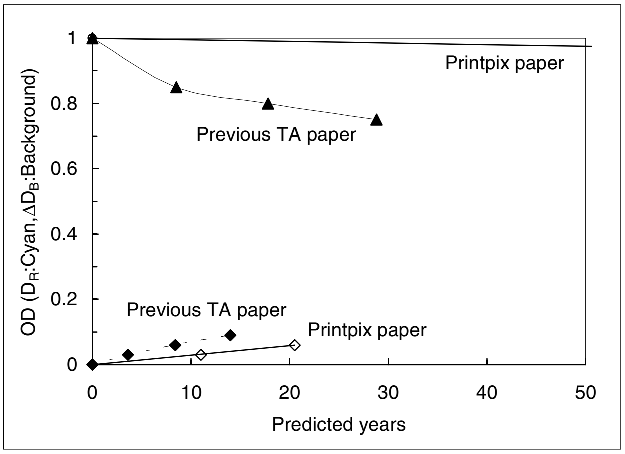

Figure 9. Predicted dark stability at 25°C 70%R.H.

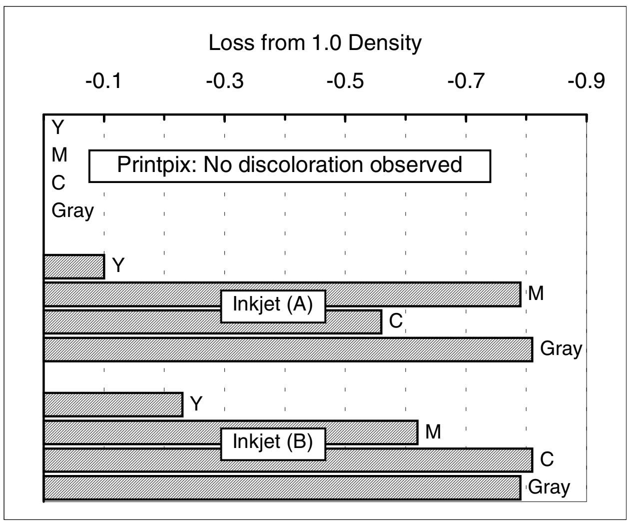

Figure 10. The ozone stability at 2.5ppm 60 hours.

Conclusions

The light stability and the dark stability of the Printpix paper shows that a remarkable improvement has been made with regard to TA paper, and the practical image stability of the Printpix paper is satisfactory. Moreover, the image on the Printpix paper was not affected by the atmospheric ozone, and the display life of the image was able to be predicted by an accelerated light test.

References

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2. Eiichi Sakai, Junichi Yoneda and Akira Igarashi: Image Stability of TA Paper, *Proc. IS&T's NIP15 Conference*, pp.235 (1999)

Biography

Eiichi Sakai joined Fuji Photo Film in 1987 after receiving his M.S. degree in engineering from University of Electro-Communications in Tokyo, Japan. Since 1987 he has worked on the research and development of thermal recording materials in the Fujinomiya Research Laboratories at Fuji Photo Film in Japan. He is currently working on the evaluation of a full color direct thermal recording system.