Gloss, Matte & Semi-gloss Finish in Thermal Dye Transfer System

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Abstract

Today thermal dye transfer technology is recognized as a convenient method to print digital photographs with comparable high quality image to that of silver halide.

For the thermal dye transfer photographs to be widely and equally used as silver halide photographs, development of high quality print media becomes indispensable. Requirements for the media are high image quality, long print durability, different surface finish, etc. As for the surface finish, a large-size print such as 8 x 10 inches often prefers either matte or semi-gloss finish instead of gloss finish. As for portrait photographs including typical 4 x 6 inch size photographs prefer gloss finish and the trend is even for glossier finish.

In the past years, we have been trying to develop various surface finish in the field of thermal dye transfer method. What we have achieved so far is high gloss print finish by using ultra-smooth donor film. In regards to matte finish, we have established a method to control roughness of the surface and as a consequence control the light reflection rate by adding necessary amount of particles into the releasing layer.

Introduction

Photograph surface finishing is generally divided into two categories, either gloss or matte. In the thermal dye transfer method the surface of a photograph is coated with a protective layer thermally transferred from the donor film onto the paper (receiver sheet) in the system. The system used so far is intended to produce gloss surface. In the past months, however, having been urged by market requirements, we have been grappling with new developments:

(i) Enhancing glossiness of photograph surface
(ii) Forming various matte photograph surface

To achieve higher gloss surface finish, we figured out we can use smoother texture donor film. To achieve matte surface finish, we can make small indents on the surface of the protective layer which is to be transferred onto the receiver sheet. By having different size indents we can control the reflection rate. Examples are provided as follows:

Experiment Section

(I) For a higher gloss type surface

The glossiness of a photograph depends on the smoothness of the surface of the protective layer. Smoother donor film surface will produce higher gloss photograph. Figure 1 shows the relationship between the glossiness of the photograph and the smoothness of the donor film. In this figure, 20° refraction is adopted instead of 45° in measuring the glossiness because it is considered as an accepted standard for the measurement of high gloss surface. Judging from the data, smoother donor film is able to produce higher glossiness. We believe this is a useful method for producing high gloss surface.*1

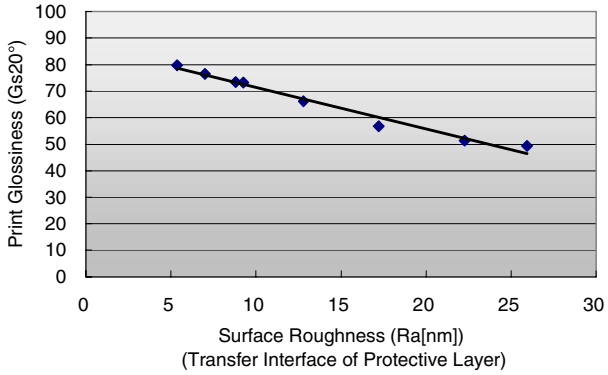

Fig. 1 Relationship between the glossiness of the photograph and the smoothness of the donor film

(II) For a matte type surface

Addition of particles

Matte type surface is achieved by adding particles in the layer adjacent to the dividing line of protective layer, Layer A or Layer B (See Fig 2.). Mixing Silysia (micro silica produced by Fuji Silysia Chemical Ltd.) into the Layer A is one of the representative methods.

In this representative case, particle-added non-transferable releasing layer A will be coated first on the base film whose surface ends up by having convex/concave formation. And then transferable protective layer B will be coated on top of it. This protective layer B will honestly transfer pre-bedded convex/concave formation onto the receiving sheet. Advantage of this method is that it is not difficult to control the reflective rate by changing the volume of the particle and/or by changing the diameter of the particle.

Figure 3 shows the relationship between gloss value and the percentage of particle added into the releasing layer.

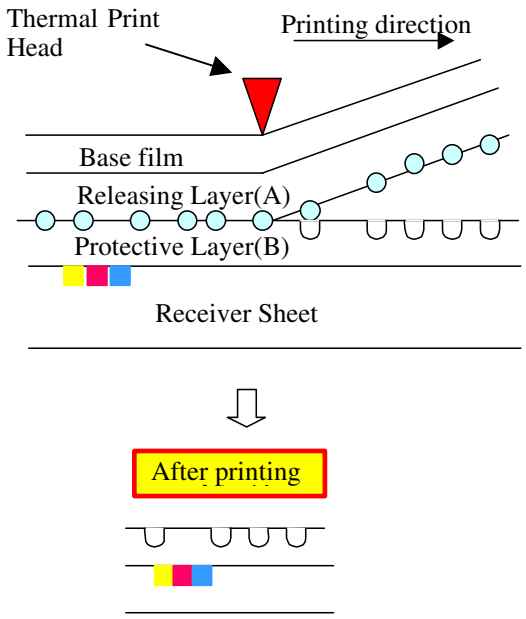

Fig. 2 Mechanism of protective layer transfer

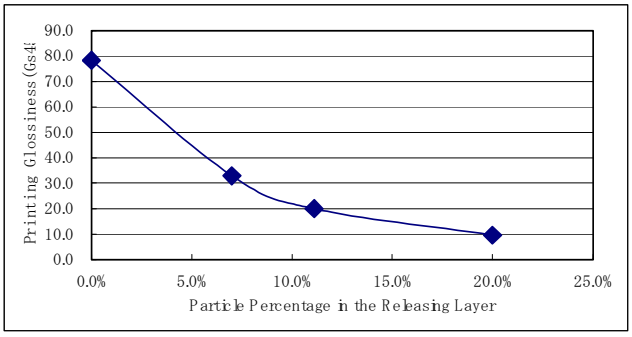

Fig. 3 Relationship between gloss value and percentage of particle in the releasing layer

The average diameter of particle size we use here is about 2.7 µm. Precisely speaking, mixing one size particle with another size may change the relationship between the gloss value and the percentage, but the tendency remains the same. Particle size can be selected if we keep in mind that adding smaller size particle requires larger amount of particle to achieve the same gloss value. Also keep in mind that using large volume of particle may end up by having inferior releasing performance since particles themselves do not have any releasing power. On the other hand, if particle larger than the thickness of the protective layer is used, there occurs partially thin protective layer area on the printed surface after the layer transfer which will weaken the durability of the printed photograph.

For example, a matte-finish photograph using 9.0 µm particle is often unable to stand the long preservation test. We have also done a brief laboratory test under conditions of 50℃, 48hrs, 4kPa of placing a softened plastic film on the photograph whose protective layer stuck to the plastic film.

Adding the thermally expandable particle in the protective layer is also reported*3. Gloss value can be controlled in this method as well.

(III) For a semi-gloss type surface

Controlling the reflection rate has been designed, tested and is now in the last phase of its development. However, there is one kind of surface which can't be realized in thermal dye transfer technology but has been produced in the silver halide technology. That is "semi-gloss surface". The characteristic of semi-gloss surface is "visual roughness pattern given on the surface of the photograph that pleases human eye". Figure 4 & 5 show the surface detail of gloss and semi-gloss of silver halide photograph. Figure 5 is our target for our thermal dye transfer photograph.

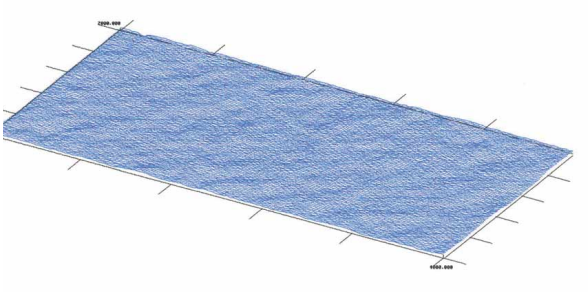

Fig. 4 Gloss Surface (Silver Halide Photograph)
Ra = 0.157

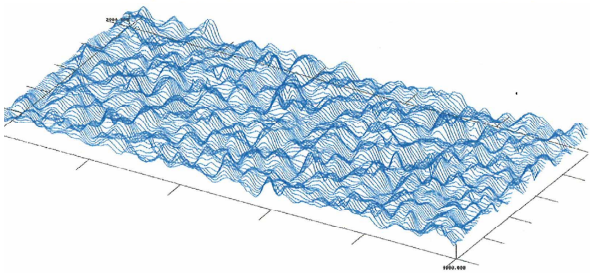

Fig. 5 Semi-Gloss Surface (Silver Halide Photograph, Target Surface)
Ra = 1.277

These figures are the data measured by 3D coordinate measuring machine. "Ra" value means "arithmetic average" roughness of the surface.

And Figure 6 below shows the typical glossiness characteristics of gloss, matte, and semi-gloss surface of photographs produced by thermal dye transfer technology.

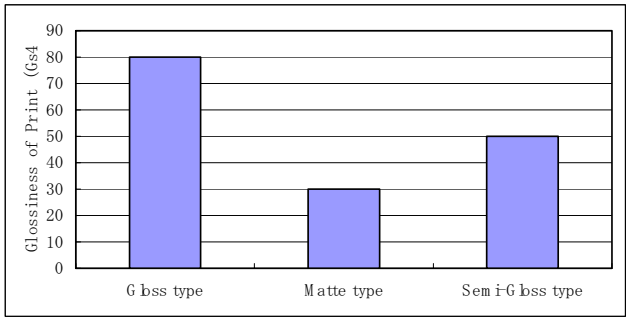

Fig. 6 Glossiness of gloss type, matte type, and semi-gloss type surface of photographs printed by thermal transfer technology

In order for the thermal dye transfer method to have the advantage as a digital photograph printing method in the future, we believe it is necessary for this method to be equipped with the same photograph surface finishing technology as is found in the silver halide technology. We will further continue developing and reproducing photograph with more desirable surface feel and texture by adding particles in a releasing layer and a protective layer. A new print method with a releasing layer and a protective layer will be another challenge of ours. One last thing we are contemplating is adding heat processing onto a printed photograph to produce matte finish.

Reference

1. D. Fukui, *New Thermal Dye Transfer Media for Digital Photo Usage*, IS T's NIP20: 2004 International Conference on Digital Printing Technologies
2. K. Hirota, and D. Fukui, Japan Patent 2004-122756
3. Jacob J. Hastreiter Jr., William H. Simpson, *Matte Finish on Thermal Prints* , IS T's NIP20: 2004 International Conference on Digital Printing Technologies