

EPSON Perfect Imaging System and New Colorfast Ink

Katsuhiko Iida
SEIKO EPSON Corporation
Shiojiri, Nagano, Japan

Abstract

Today inkjet prints have spread widely. Image quality of inkjet prints with dye ink has been improved and reached a high level, and then users' interests are shifting to preservation of prints. Especially, light-fastness is expected to improve. Generally speaking, although light-fastness can be improved with pigment ink, image quality of pigment ink is lower than that of dye ink. Seiko Epson developed new pigment ink, EPSON ColorFast ink. And both high image quality and high light-fastness are achieved with EPSON ColorFast ink and EPSON Perfect Imaging System which consists of piezo-head technology, EPSON genuine media, high accurate mechanism, advanced imaging processing software.

1. Introduction

Inkjet printers have spread from business users to home users widely as PC peripheral devices. Image quality of inkjet prints have been improved dramatically, and inkjet printers are recognized as devices which meet home users demand that they would like to print photographs easily and quickly. Currently, improvement of print quality reached to a high level level, users' interests are shifting to preservation of inkjet prints, especially light-fastness.

Also, in the large format printer market – large size graphics and photographs market –, light-fastness is added value because the prints are often put on an indoor/outdoor wall. Therefore, light-fastness is big concern for users.

This paper will describe the inkjet image-quality and light-fastness improvement technology, especially new pigment ink, called EPSON ColorFast Ink. Generally, pigments can improve light-fastness, but its quality is lower than that of dye ink. Seiko Epson studied the characteristics of pigment, and developed EPSON ColorFast ink which achieved both high image quality and high light-fastness. It is used for EPSON LFPs (Large Format Printers), StylusPro-5500/7500/9500.

2. High Image Quality Technology of Inkjet Print

At first, high image quality technology of inkjet print called EPSON Perfect Picture Imaging System is explained in brief.

For inkjet printer, high image quality is realized with all these 5 elements.

- 1) Accurate control of ink droplet--- Piezo Printhead
- 2) Superior ink --- EPSON Genuine Ink
- 3) Suitable print media --- EPSON Genuine Media
- 4) High accurate printhead scan
and paper feeding technology --- Mechanism
- 5) Advanced image processing technology --- Software

In these, 1) and 2) directly affect composition and physical property of ink.

2-1 Control of Ink Physical Property

For high image quality of inkjet printer, accurate ejection of ink droplet and clear dot form on the media are the necessary conditions. Droplet mis-alignment and ink mist are the biggest factors to lower the image quality.

For higher image quality, higher resolution and smaller ink droplet are necessary. Head nozzle increase and improvement of dot firing frequency are also indispensable because higher printing resolution reduces the speed. Therefore, accurate ejection of ink droplet and clear dot form are getting more difficult to be achieved. For stable ejection, it is very significant to control ink characteristic and to match it with head driving conditions.

EPSON inkjet head, called MACH (Multi-layer ACTuator Head) controls accurately ink meniscus with 3 steps process called PPP (Pull Push Pull); before ejection, at ejection, and after ejection. It is important for ink characteristic to be controlled not only static physical property like viscosity and surface tension, but also kinetic physical property like viscoelasticity and wet characteristic with ink head materials, especially materials of nozzle.

2-2. Super-Penetrating Ink

Ink is the most important element for inkjet image quality. The required ink characteristic depends on purpose of printer use, so it is necessary to consider the specification in design phase.

Seiko Epson uses super-penetrating ink for inkjet printers. This ink penetrates the paper in 10ms after the ink droplet reaches the paper surface. Therefore, it has following features,

- Quickly drying,
- No color bleeding
- Low ink running cost.

The ink for inkjet printing requires other basic characteristics; no clogging after leaving for a short/long term, ink stability against touching material (materials of head, ink cartridge, and so on), and long preservation.

3. Improvement of Light-Fastness by Pigment Ink

For inkjet printers, dye ink was used mainly in the past because dye ink is comparatively superior with color saturation, and reliability for nozzle clogging. The following table shows difference between dye ink and pigment ink.

Table 1. Comparison of dye ink and pigment ink

	Dye ink	Pigment ink
Absorption spectrum	Sharp	Broad
Color Saturation	Excellent	Good
Water-proof	Good	Excellent
Light-fastness	Good	Excellent

In case of water-based ink, dye is soluble in water and as a molecule. All molecules participate in color development and absorption spectrum is very sharp, so color saturation is extremely high. However, this feature that all molecules participate in color development causes immediately color fading when dye molecules are destroyed by light.

On the other hand, pigment ink is insoluble in water. Pigment molecules are dispersed into ink as particles. Unlike dye, all molecules of pigment particle are not under same environment. Therefore, absorption spectrum is broad, and image is not vivid comparing with dye ink. Besides, only some parts of pigment on particle surface participate in color development, so color density is low, and the image is dull. However, it has superior light-fastness because even if pigment on particle surface is destroyed by light, because not all pigment participates in color development, and pigment existing under the layer develops color.

Until now, there were 2 key issues for pigment ink to be applied to inkjet products; reliability and print quality. About reliability, pigment used to be easy to clog around nozzles, because it is insoluble in water. Especially, indispensable surfactant and penetrating agent, which are used to control ink property for high image quality used to make stability of dispersion unstable.

4. Features of EPSON ColorFast ink

Seiko Epson improved pigment purification, crystallization process, dispersion process, and ink composition, and then developed ColorFast ink with both high image quality and light-fastness.

EPSON ColorFast ink has following 3 features;

- Excellent light-fastness and high color saturation with controlling size of pigment particles.

- High reliability and high color saturation with resin-coated pigment particles.
- Stable dispersion with selection of suitable pigment.

4-1 Control of Pigment Particle Diameter

Pigment particle diameter extremely affects both light-fastness and color development. Generally, there is trade-off relationship between light-fastness and color saturation. Bigger particle has higher light-fastness. However, ratio of pigment that doesn't participate in color development increases, color saturation becomes lower. On the other hand, if particle size is small, light-fastness is low.

We tested various particle sizes of pigment ink, and optimized particle diameter that keeps both light-fastness and color saturation. It is hard to say value of pigment particle diameter, because it changes depending on method of measurement. However, as far as we observed with an electron microscope, we found the optimum particle diameter is 100 ~ 150nm, and we applied it to EPSON ColorFast Ink (Figure 1).

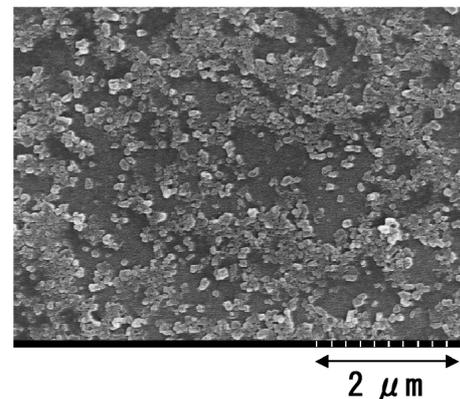


Figure 1. Pigment particles of EPSON ColorFast Ink

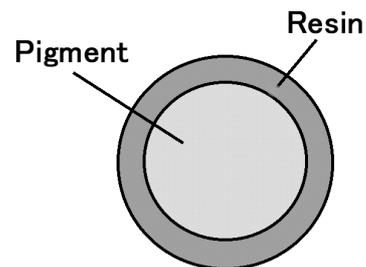


Figure 2. Pigment particles coated by resin

4-2 Covering Pigment Particles With Resin

Pigment surface is hydrophobic. Therefore, to make dispersion of pigment in water stable, the surface is necessary to be hydrophilic. There are two method to disperse pigment; one is the method with surface treatment, and another is the method with dispersing agent.

In case of the method with dispersing agent, pigment is covered with water-soluble resin or surfactant which have both hydrophilicity and hydrophobicity. Generally the stability and solvent-resistance with high temperature are inferior comparing to surface treatment because dispersing agent usually connects to pigment only with absorption power. However, when water-soluble resin is used as dispersing agent, high reliable ink can be manufactured because the resin adheres to plural points of pigment particle.

We selected the method for EPSON ColorFast ink that pigment particles are wrapped up in a water-soluble resin to adhere firmly and to disperse in water stably (Figure 2).

Covering pigment particles with the resin has following effects as well;

The first effect is to reduce diffused reflection of light on the print surface. Because EPSON ColorFast ink forms smooth surface with pigment particles covered with water-soluble resin, it can prevent light from reflecting diffusely (Figure 3).

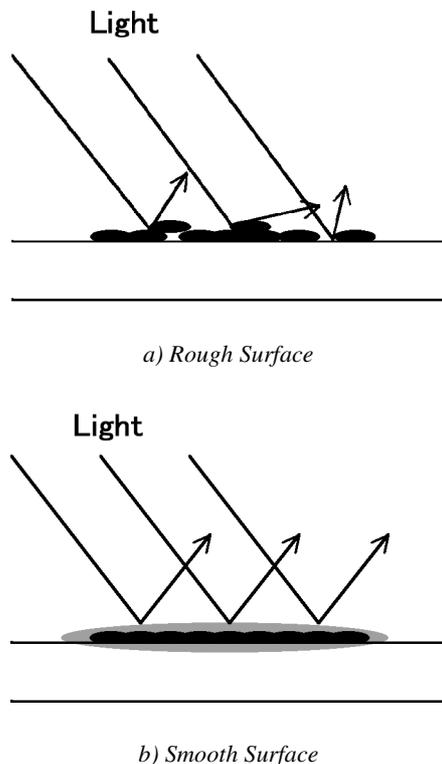


Figure 3. Light reflection on the media

The other effect of covering with resin is improvement of scratch-resistance. In case of pigment ink, it is difficult to make scratch-resistance better, because most of pigment particles stay on the print media surface than dye particles that penetrate into media deeply. Actually, some inkjet printers using pigment ink on the market has the problem of dirt that happens with scratching with a finger or a marker pen, even when long time passed after print. Especially with glossy media, this

problem is more serious because more particles stay on glossy media surface. In case of EPSON ColorFast ink, scratch-resistance is good because pigment particles are fixed strongly to the media surface with water-soluble resin around pigment.

4-3 Selection of Pigment with High Light-Fastness

As I mentioned before, if pigment size is smaller, light-fastness becomes lower. To achieve both light-fastness and color saturation, materials of pigment that have good light-fastness should be selected. For EPSON ColorFast ink, we selected the pigment type with high light-fastness and stable dispersion for all of 6 colors; 4 basic color yellow, magenta, cyan, and black plus light-magenta, light-cyan.

We had acceleration test of light-fastness with a fluorescent lamp acceleration test device assuming indoor preservation in a glass frame. As a result, we can estimate EPSON ColorFast ink has light-fastness more than 200 years.

5. Conclusion

EPSON ColorFast ink is being recognized in the inkjet printer market as ink which achieve both high image quality and high light-fastness with resin-coated pigment. And we realized that that market of inkjet printer is getting bigger with improvement of light-fastness. However, with this ink, sufficient print quality is assured only with special coated print media. We need to improve it for good color saturation with any media to spread among fine art market and business market.

We also need to improve printing speed of inkjet LFP to spread more among other segments in the market. As the present situation, the print speed is far behind plate-making print for large quantity printing, although it has a merit of short time and low cost for various kind printing for small quantity. Further improvements of ink reliability and firing characteristic are indispensable to improve print speed, for example, increase head nozzles and dot firing frequency.

Further improvement of light-fastness will raise the value of inkjet prints and expand the inkjet graphics market. It is very important to keep higher image quality when light-fastness, print speed, various media support will be improved.

Biography

Katsuhiko Iida is a manager in the Inkjet Design Department of SEIKO EPSON Corporation. He received his B.E. and M.E. in mechanical engineering from the Tokyo Institute of Technology, Japan, in 1979 and 1981 respectively. He worked on plotter system for two years, print-head development for two years, inkjet product development for ten years and currently is working on large format printer product planning. His primary responsibilities are product planning of large format printer. His recent interests are the optimum combination among ink, printhead, media and mechanism for high image quality output.