Development of New Polymerization Full-Color Toner

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Abstract

The new oil-less full color toner was developed by ester elongation polymerization method.

The new polymerization toner consists of toner ingredients such as polyester resin, wax, and pigment realized low temperature and oil-less fixing. In addition, low temperature fixing and heat-resistance, moderate gloss by controlling molecular weight distribution of polyester binder were attained by using ester elongation polymerization method. Furthermore, it achieved high image quality that the fine toners with small and narrow particle size distribution . In addition, it is possible to use blade-cleaning system by toner shape control technology.

Introduction

Since 1990's, when electro-photographic printers were fused with digital technologies, there have been technical advancements in colorization of electro-photographic printers and increasing demands for high quality images have been. The most promising thing necessary for obtaining a high quality image must be to develop a latent image faithfully with use of fine particle size. In addition, fine toners may lead to reduction in the consumption of the toner.

Conventional toners are manufactured by heating the and melt-blending of the materials followed by pulverizing them in air. Creation of small particle size toner by pulverizing method encounters difficulties because of the larger impact energy and lower productivity rate. Furthermore, toner ingredients such as colorants and waxes tend to be exposed on the surface of toner, resulting to problems such as a carrier spent and generation of poorly charged particles.

Using a new manufacturing method, we have developed a new polymerization toner which gives a superior performance that was not able to achieve by the conventional method. This report is a summary of the oil-less polymerization color toner created by new manufacturing method.

Technology

The Characteristics and the Manufacturing Method of the New Polymerization Color Toner

Conventional pulverization toner is manufactured through heating and melt-blending process and pulverization process in air. Our new polymerization toner, however, utilizes 'ester elongation polymerization', so that it is manufactured through wet process, similar to suspension polymerization method and dissolution suspension method. A small particle size and narrow particle size distribution can be easily controlled to the level that the pulverization method cannot achieve. It is also possible to keep the colorant and wax inside toner particles by controlling the conditions of the manufacturing process. In addition, it is possible to produce particles with spherical, spindle, or dimple form.

Thus, we intended to design the particle structure of new polymerization toner, so that network type high molecular weight polyester chains exist in the matrix composed of low molecular weight polyester resin for low temperature fixing, better heat resistance and a reduced possibility of hot-offset (Fig. 1). The structure of new polymerization toner brought about simultaneous high heat-resistant and low temperature fixing.

Another characteristic of the new toner is that, the shape of toner allows for blade-cleaning.

The production of new polymerization toner consists of six processes as follows (Fig. 2).

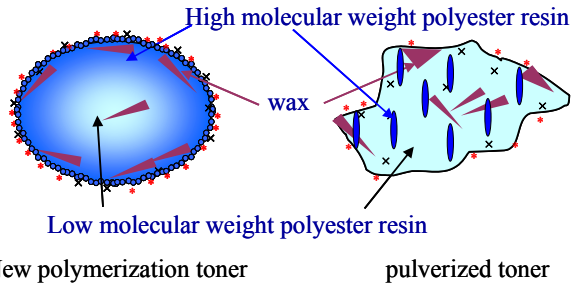

Figure 1. Illustration of new polymerization toner and pulverized toner.

(1) Preparing Oil Phase and Water Phase

Wax dispersion in an organic solvent is prepared and is mixed with a solution including polyester resin, pre-polymer and pigment, making the oil phase. At the same time, a size control agent and a surface active are mixed in water, making a water phase.

(2) Emulsification and Elongation

The oil and water phases are mixed together and emulsified. After emulsification, oil droplets including wax, polyester resin and pigment, etc are formed. The oil droplets converge to be united to sharp particle size distribution, while the ester elongation polymerization reaction proceeds simultaneously.

(3) Removal of the Solvent (Desolvent)

The solvent in the oil droplets is removed from the slurry solution, and solid particles are obtained.

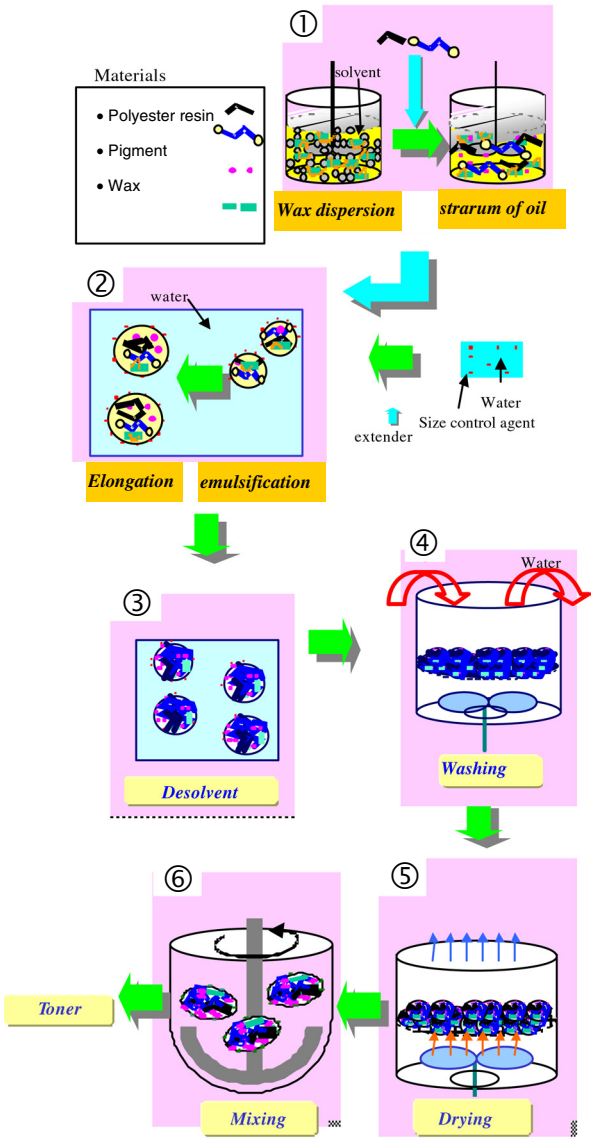

Figure 2. Production scheme of new polymerization toner.

(4) Washing & (5) Drying

The impurity on the surface of toner particles is washed away with water. After that, the surface moisture and internal moisture are evaporated. Thus dry powder is obtained.

(6) Mixing

The toner particles are mixed with external additives and the product toner is created.

Development of New Polymerization Toner

Low Temperature Fixing

In the development of new polymerization toner, we tried to control viscoelasticity of the toner by using a low molecular weight polyester resin and high molecular weight polyester resin. As shown in Fig. 3, contolling the molecular weight of the binder and viscoelasticity resulted in the wide temperature width for fixing. The toner providing appropriate temperature range for fixing indicated a gentle curve for viscoelasticity compared with a conventional toner, as shown in Fig. 4. Owing to the less variable viscoelasticity. the new polymerization toner showed a uniform image gloss as shown in Fig. 5.

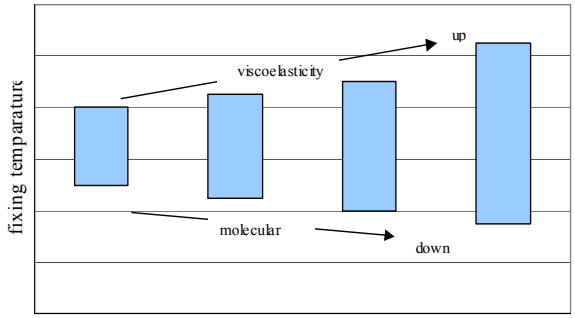

Figure 3. Relationship between fixing temperature and viscoelasticity.

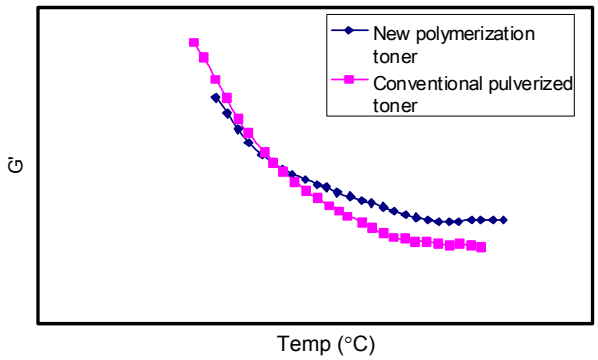

Figure 4. Relationship between viscoelasticity and temperature.

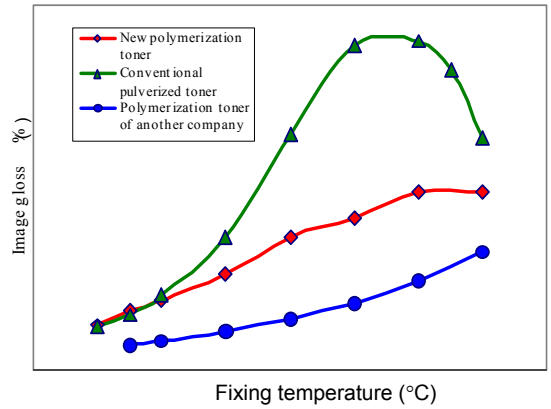

Figure 5. Relationship between imaging gloss and fixing temperature.

Particle Size Distribution

In the new polymerization toner, we adjusted the process condition properly to obtain proper toner size.

Figure 6 shows particle size distribution of new polymerization toner. The particle size distribution of new polymerization toner is narrower than that of conventional pulverized toner.

Shape Control

The new polymerization toner has been formed to a dimple-shape, so that it can be adapted to the blade-cleaning system. We attempted to make a surface unevenness by controlling the conditions of the manufacturing process. As a result, we created the dimple-shaped toner, and high blade-cleaning performance (Fig. 7).

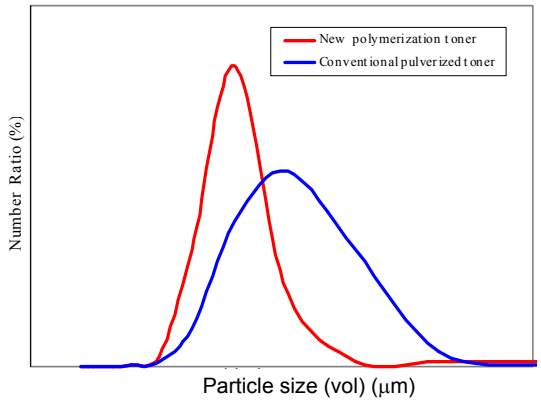

Figure 6. Particle size distribution of new polymerization toner.

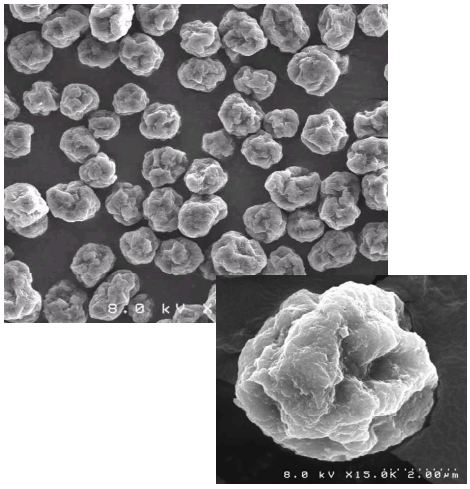

Figure 7. Shape of new polymerization toner.

Results

Achievement of High Image Quality by Small Particle Size

Figure 8 shows a reproducibility of characters and dots by the new polymerization toner compared with the conventional pulverization toner.

The new polymerization toner has less toner spattering in non-image areas and reproduces the more uniform image. Furthermore new polymerization toner can reduce about 25% amount of toner consumed to get enough image density, comparing with the conventional pulverization toner.

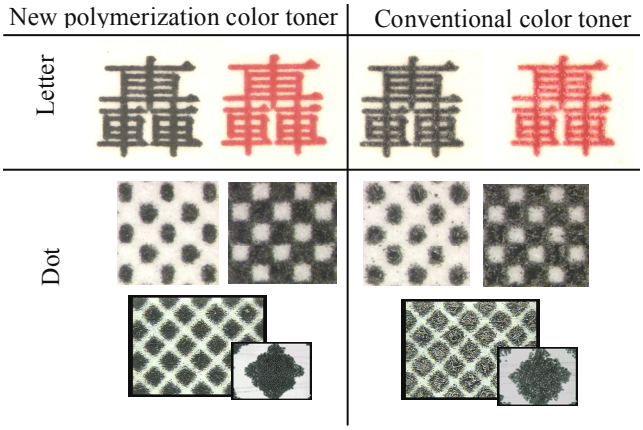

Figure 8. Reproducibility of new polymerization toner and conventional toner.

Realization of Blade-Cleaning System by Toner Shape Control

The new polymerization toner method can control the shape of toner to make blade-cleaning possible.

Conclusion

By the new method for polymerization toner, several features were obtained such as lower temperature fixing performance, production of higher image quality, more reduction of toner consumption etc, compared with the conventional pulverized toner.

Author Biography

As Manager for Ricoh Company, Ltd., in Tokyo, Japan, Fumihiro Sasaki is responsible for designing toners and developers for new imaging system.

Having graduated from Tokyo University of Science with a bachelor of physics, Sasaki has been associated with toner design and evaluation over these last 20 years.