High Image Quality and Stability of Electrophotographic System Using Full Color Chemical Toner

Takamasa Ozeki, Akira Azami ,Masumi Sato, Fumihiro Sasaki, Tomio Kondoh, Akihiro Kotsugai,*
Ricoh Company , LTD , Kanagawa , Japan

Abstract

In this paper, newly developed electrophtographic system, Imagio-Neo C455 released in January 2005 is described. It employs new smaller size full color chemical toner (named PxP toner:Polyester x Polymerization) and new process technologies. This PxP toner is under 6um in diameter and more spherical with the dimpled surface. Moreover, it achieves lower temperature fusing system without fusing oil by using polyester resin. At the same time, two important development technologies are introduced. One is narrow gap using DC bias, and the other is smaller size carrier. By introducing these new technologies, the Imagio-Neo C455 achieves excellent image quality and stability.

Introduction

Market demands higher image quality and reliability towards copiers and printers year after year, in accordance with their digitalization, colorization and multifunctionization. It is also essential to design products and manufacturing processes with the consideration of environmental conservation. In order to meet these demands, most of providers have been developing polymerized toners, which are smaller in particle size, lower in energy consumption in its manufacturing process, and shape-controllable. Ricoh had also developed polymerized toner (named PxP toner: Polyester x Polymerization) for black/white MFP and has applied it to Imagio Neo 451 launched in March 2003.

And next, we have developed this PxP toner into color system Imagio Neo C455,and achieved dramatic improvement of image quality and stability.. This Imagio Neo C455 is mainly based on former successor model, Imagio Neo C385, which was launched in September 2003, needed some optimization.

In this paper, we introduce what kind of image quality improvements of Imagio Neo C455 were achieved by adopting this small particle polymerized toner, comparing to Imagio Neo C385.

Table.1: Specifications

	Imagio Neo C385	imagio Neo C455
Copy speed	B&W :38 cpm Color :28cpm	B&W :45 cpm Color :35cpm
First copy time	B&W :7.4sec Color :9.8sec	B&W :5.8sec Color :7.8sec

Modified points toward Imagio Neo C455

With regards to the conditions of the supplies and machines, the following points have been modified.

1. Developer
   1) Toner (Color PxP toner): 15% smaller in particle size compared with pulverized toner of Imagio Neo C385
   2) Carrier: 35% smaller in particle size
2. Development condition
   3) Bias: DC bias only
   4) Gap to Photoconductor: 20% narrower
   5) Speed ratio to Photoconductor: 30% faster

These parameters are mainly described as they are contributing to improvement of imaging quality a lot.

New Color Polymerized toner (Color PxP toner)

This Color PxP toner is manufactured by Ricoh's new polymerizing method. This method is already used for B/W PxP toner which is already on the market. The distinctive point of PxP toner is that it consists of polyester resin. PxP toner is smaller and its shape is more controllable. Using the PxP toner, a super reproduction of dots can be achieved, so that the printing image has a higher quality.

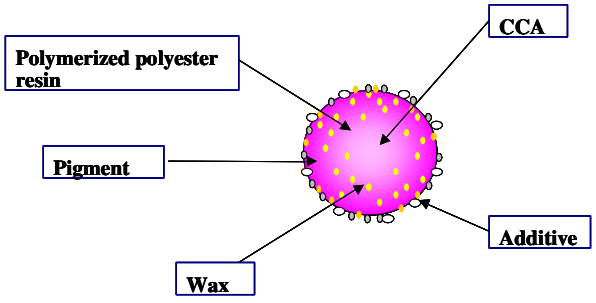


Figure 1. *Color PxP toner*

Particle size and shape design

We were successful in making the particle size of Color PxP toner smaller by 15%, compared with pulverized toner of Imagio Neo C385. Narrower distribution of particle sizes has also been achieved. (Figure 2)

The shape of Color PxP toner is shown as Figure 3(b), compared to the shape of pulverized toner shown as Figure 3(a). The PxP toner is more spherical with the dimpled surface. It has contributed to improving high transfer efficiency and margin for cleaning capability.

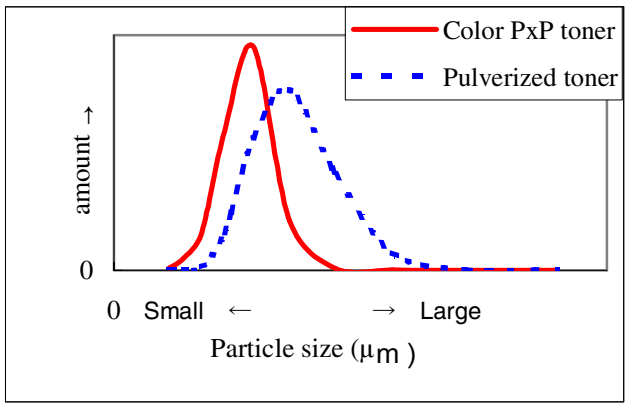
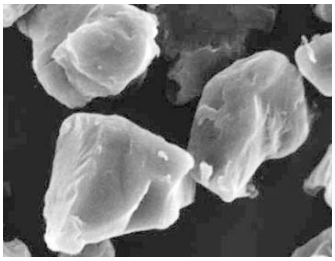
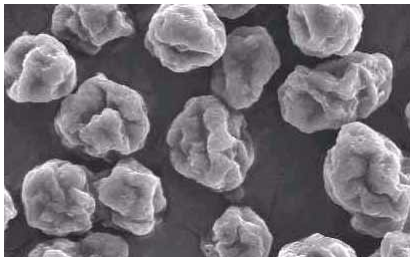


Figure 2. *Particle size distribution*



3(a) *Pulverized toner*



3(b) *Color PxP toner*

Figure 3. *SEM image of toner particles (x2000)*

Design for charge

In Color PxP toner, by improving the method of adding the additive for charge control to toner, evenness of charging has been achieved. In addition, by optimizing the charging capability of toner before adding the additive and carrier, the distribution of charging amount has been narrower than the conventional pulverized toner. (Figure 4)

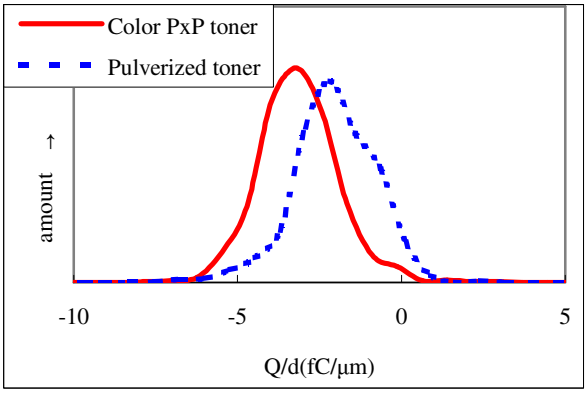


Figure 4. *Charge of particle size distribution*

Improvement of image quality of dots and line

On OPC

By applying to smaller particle size of toner, dot reproduction level on OPC has been drastically improved. (Figure 5)

Also with smaller size of carrier (Figure 6), dot reproduction level can be improved. (Figure 7)

These toner and carrier, which are smaller size than conventional them, are applied to Imagio Neo C455.

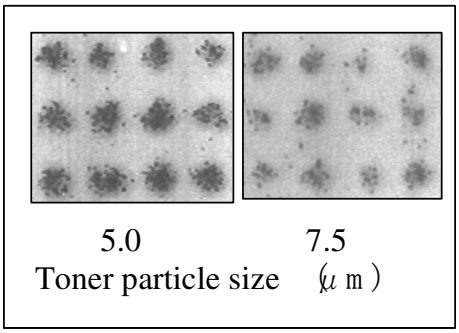


Figure 5. *Dots image on OPC with toner particle size*

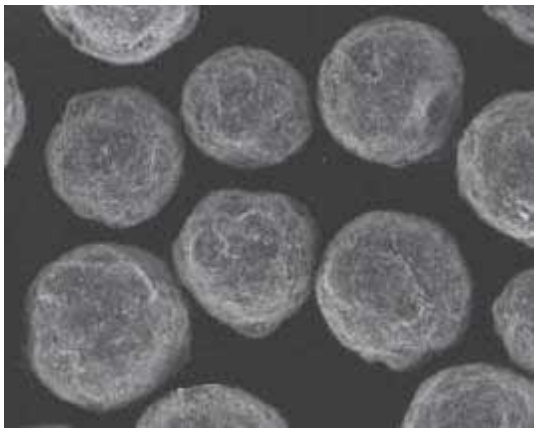
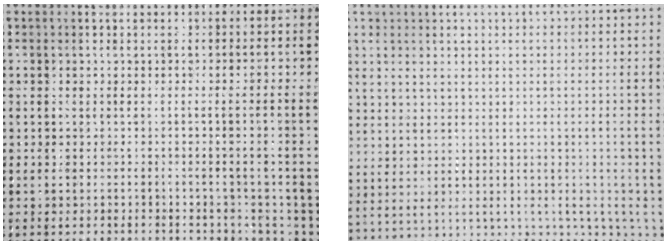


Figure 6. *SEM image of carriers (x 1000)*



(a) using the previous carrier (b) using the carrier 35% smaller

***Figure 7**. Dots image on OPC with carrier particle size*

Image Transfer/Fusing

By using polymerized toner with small particle and optimizing the amount and kind of additive for the toner, reduction of adhesion to photoconductor and lower pile height has been achieved. (Figure 8)

Accordingly, deterioration level of image quality in image transfer and fusing process has been improved. Also by using toner with wax, fusing system doesn't require fusing oil, so that print image has a smooth gloss. (Figure 9)

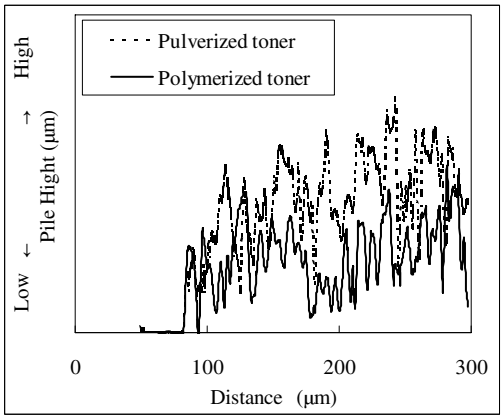


***Figure 8.** Pile height*

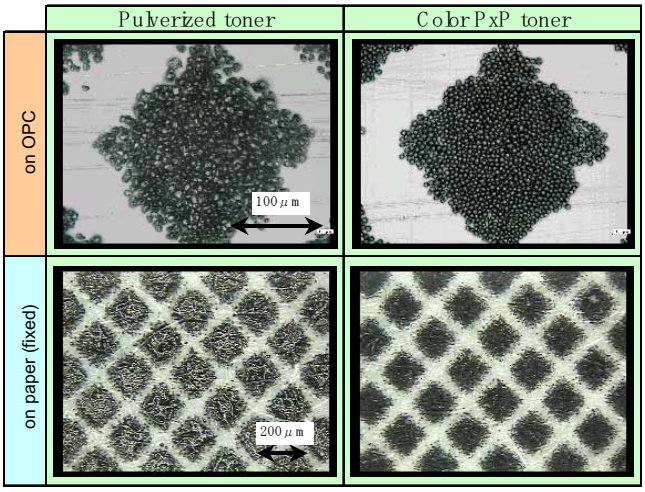
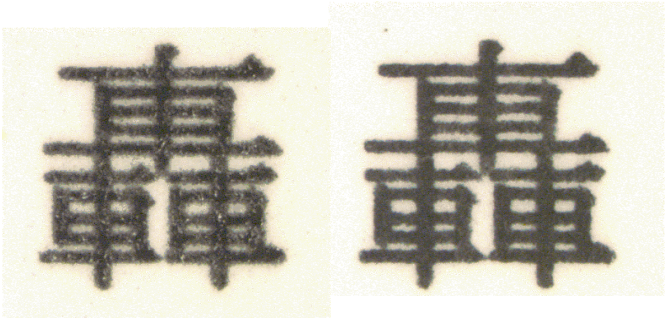


***Figure 9.** Toner image on OPC and paper*

Image quality comparison between Imagio Neo C455 and Imagio Neo C385

As the result of the above image quality designing, the comparison between Imagio Neo C455 and Imagio Neo C385 for character image and granularity are shown in Figure 10 and 11 respectively. It is clearly shown that Imagio Neo C455 is sharper in character image, and smoother gloss. And with respect to granularity, it has less rough dots especially for lighter area.



(a) Imagio Neo C385 *(b) Imagio Neo C455*

***Figure 10.** Comparison of line image (x15)*

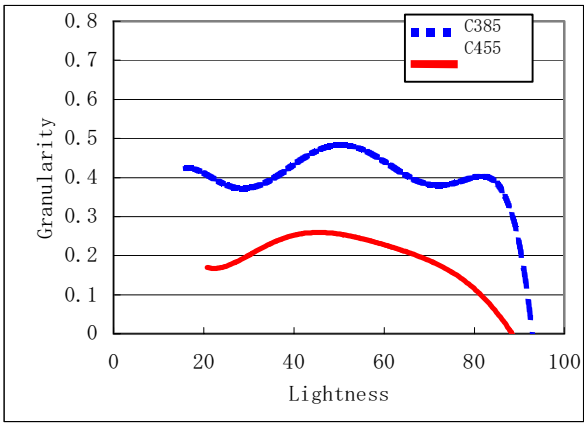


***Figure 11.** Comparison of granularity*

Image stability

Condition of Development

With regard to development capability using DC bias compared to using AC bias, the result of experiment conducted with the experimental device for measurement. Generally, using DC bias has lower development capability compared to using AC bias. However, using DC bias has advantage in dirty background level and in scattering level of character image over using AC bias.

By reducing development gap to photoconductor by 20%, and increasing development speed ratio to photoconductor by 30%, development capability using DC bias can be improved up to the using AC bias level. (Figure 12)

By applying to the above points, DC development bias with high margin for dirty background can be loaded on Imagio Neo C455.

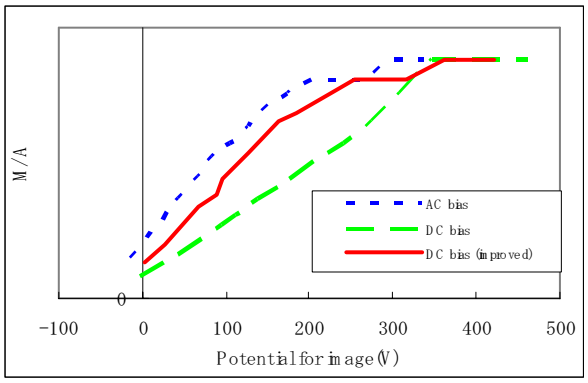


Figure 12. *Development capability in DC/AC bias*

In addition, in case of pulverized toner, the granularity highly depends on whether using DC bias or using AC bias. The experimental result of the granularity in using DC bias and using AC bias with the small particle polymerized toner is shown in Figure 13. It shows that the same level of granularity as using AC bias can be achieved by using DC bias, in the case small particle polymerized toner. By applying to the above points, DC development bias with high margin for dirty background and super reproduction of character image can be loaded on Imagio Neo C455.

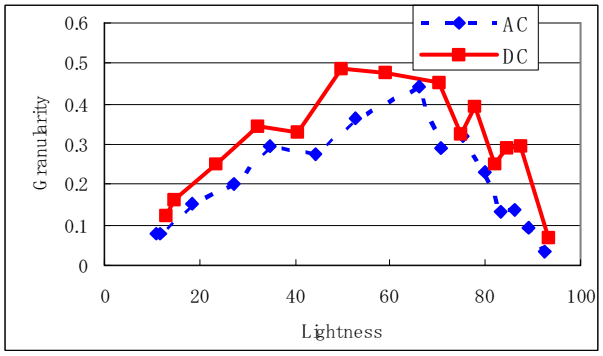


Figure 13. *Granularity in DC/AC development bias (using polymerized toner)*

Stability of image density

By applying the higher covering ratio from smaller particle size, narrower distribution of particle size, more spherical shape, and higher pigments ratio, the same image density has been achieved with lesser toner amount for Color PxP toner compared to the pulverized toner.Accordingly, Imagio Neo C455 can reduce toner consumption drastically compared to Imagio Neo C385. Therefore, a change of the toner density was reduced, and a change of the image density was improved, too. In addition to that, PxP toner has reduced the fluctuation of image gloss at the same time.

Fig.14 compares the fluctuations of image density of Imagio Neo C455 and C385 under solid printing. It shows that Imagio Neo C455 achieves very low fluctuation of image density compared with C385.

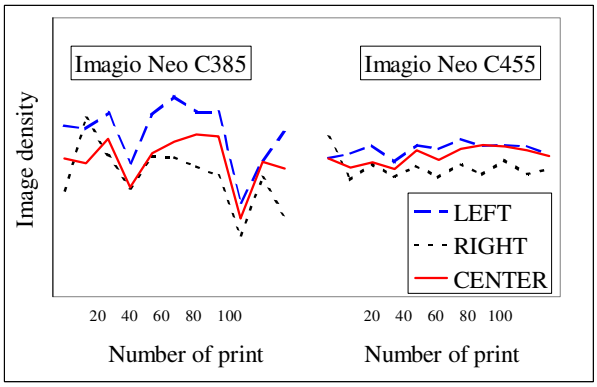


Figure 14. *Comparison of stability of image density*

Summary

By applying newly developed polymerized color toner and development system using DC bias, superior image quality with high stability has been achieved for Imagio Neo C455.
It is significant to target on higher image quality and reliability with environment conservation view points, continuously.

References

[1] Akira Azami et al., Japan Hardcopy 2005, A-34(p247-250) (in Japanese)
[2] Fumihiro Sasaki et al., J. Imaging Society of Japan, 54-59, 43(2004) (in Japanese)
[3] Masumi Sato et al., NIP21, 574-577, (2005)

Author Biography

Takamasa ozeki received his MA in materials science and engineering from the University of Nagoya and joined Ricoh Company Ltd. in 2000. Since then he has worked in research and development section at Ricoh. In recent years, he has engaged in development color electrophotographic printing engine.