

Fine Image Quality by Using Small Size Full Color Chemical Toner and New Process Technologies

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Abstract

Imagio Neo C455, released in January 2005 in Japan, achieves superior image quality by using a newly developed set of full color chemical toners and several new process technologies. The new toner is under 6µm in diameter. Moreover, it consists of polyester resin and it enables the lower temperature fusing system without fusing oil. Also, it uses the improved development technology with narrow gap using DC bias and a small size carrier.

Introduction

Market demands towards higher image quality and reliability are increasing year after year, in accordance with the digitalization, colorization and multifunctionization of copiers and printers. It is now essential to design products and their manufacturing processes from environmental conservation viewpoints. In order to cope with these market demands, most of the providers have been developing polymerized toners, which are smaller in particle size, lower in energy consumption in its manufacturing process, and shape-controllable. Accordingly, 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.

This time, we have evolved this PxP toner into color toner, and achieved dramatic image quality improvement, by adopting it with optimized designing to the successor model of Imagio Neo C385 launched in September 2003.

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: 38cpm Color: 28cpm	B&W: 45cpm Color: 35cpm
First copy time	B&W: 7.4cpm Color: 9.8cpm	B&W: 5.8cpm Color: 7.8cpm

Modified Points from Imagio Neo C385

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

1. Supply

- 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: using 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 with Ricoh's new polymerizing method, which is already used for B/W PxP toner being marketed. The PxP toner consists of polyester resin, which is the distinctive point. The 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.

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).

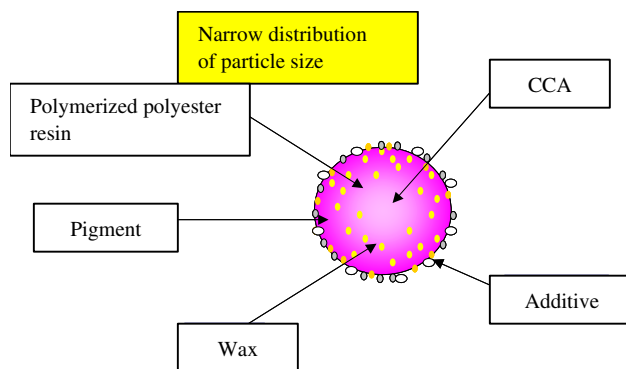


Figure 1. Color PxP toner

The shape of Color PxP toner is as shown Figure 3(b), compared to the shape of pulverized toner as shown 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.

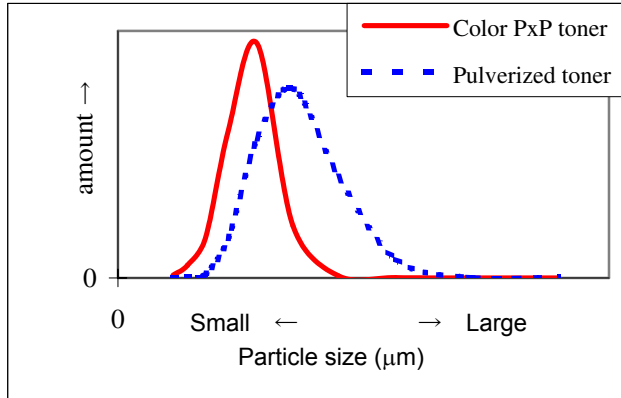
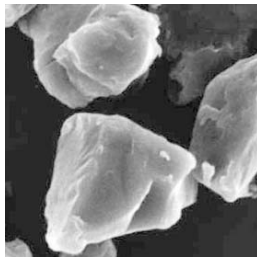
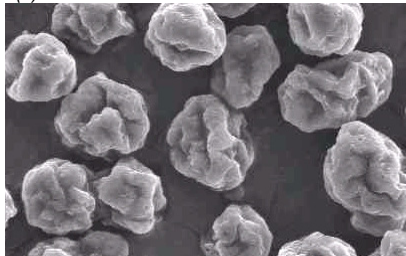


Figure 2. Particle size distribution



3(a) Pulverized toner



3(b) Color PxP toner

Figure 3. SEM image of toner particles (x2000)

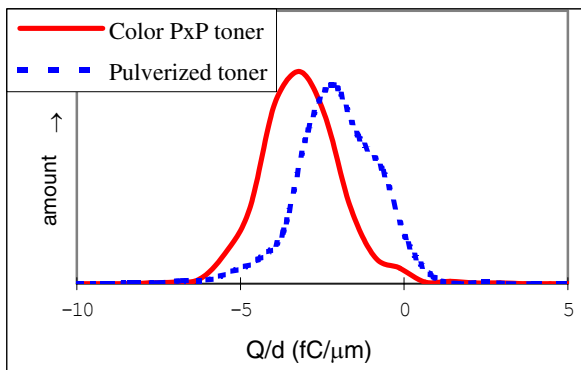


Figure 4. Charge of particle size distribution

Charging Design

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)

Environmental Conservation

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 (Figure 5).

Further, drastic energy saving has been achieved in Color PxP toner manufacturing method compared to the conventional pulverized toner (Figure 6).

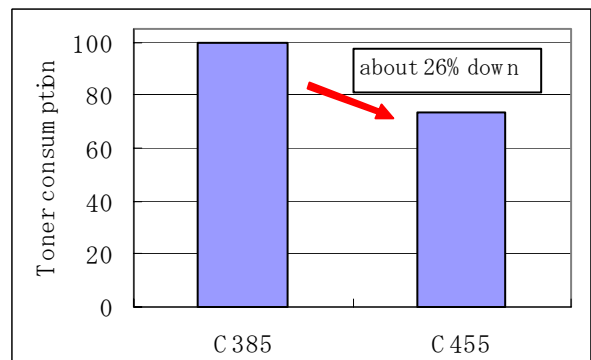


Figure 5. Comparison of toner consumption (Imagio Neo C385 = 100)

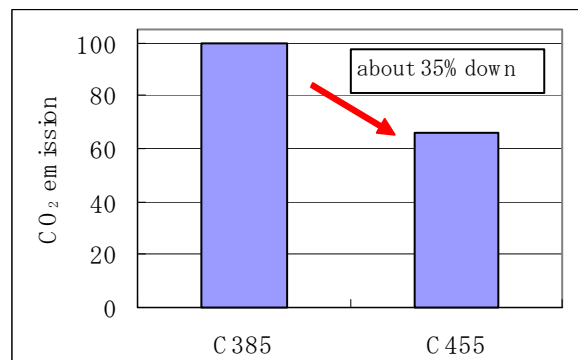


Figure 6. Comparison of CO₂ emission (Imagio Neo C385 = 100)

Image Quality Improvement Toner/Carrier

By applying to smaller particle size of toner, dot reproduction level has been drastically improved (Figure 7).

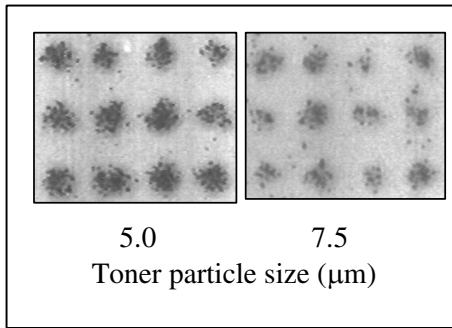


Figure 7. Dots image on OPC with toner particle size

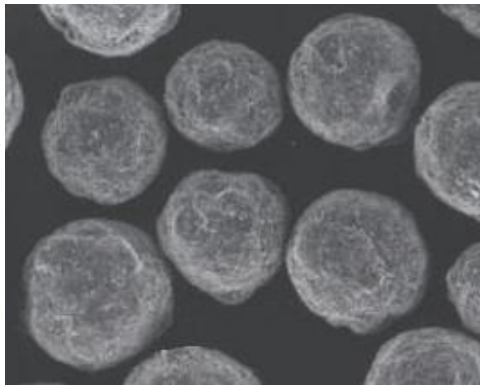


Figure 8. SEM image of carrier (x 1000)

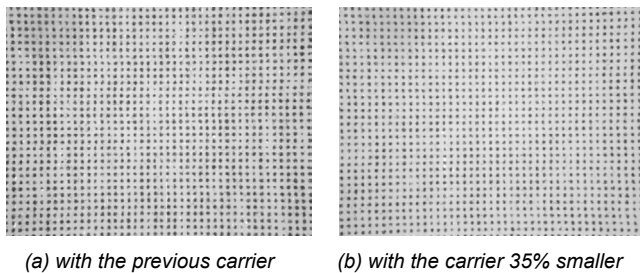


Figure 9. Dots image on OPC with carrier particle size

Also with smaller size of carrier (Figure 8), dot reproduction level can be improved (Figure 9).

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

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 10).

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 11. 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.

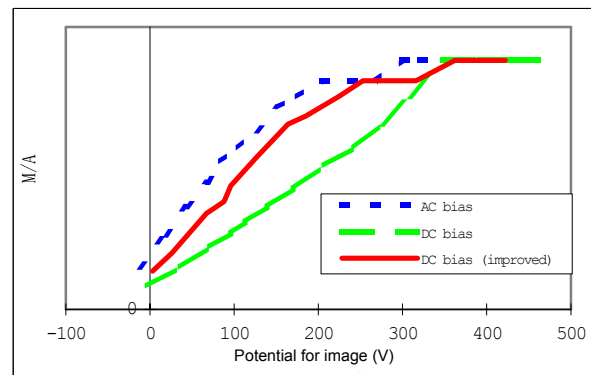


Figure 10. Development capability in DC/AC bias

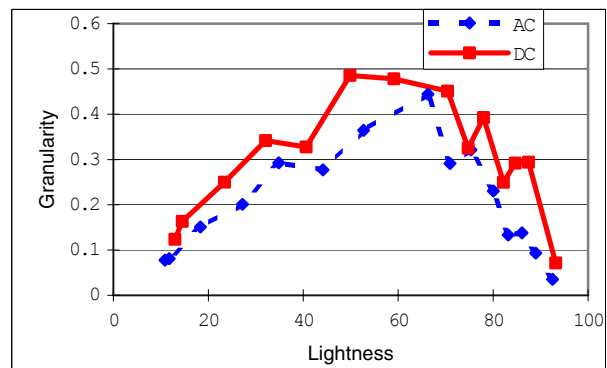


Figure 11. Granularity in DC/AC development bias (using polymerized toner)

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 12).

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 13).

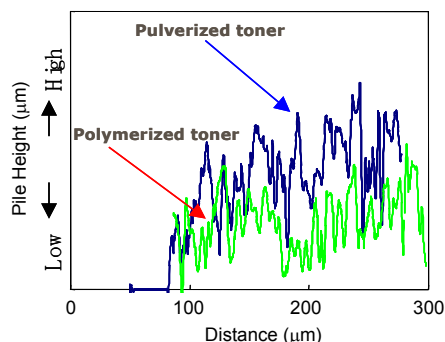


Figure 12. Pile height

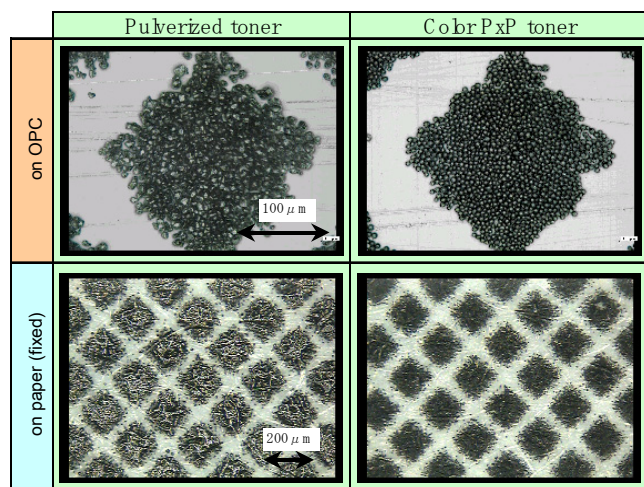


Figure 13. Toner image on OPC and paper

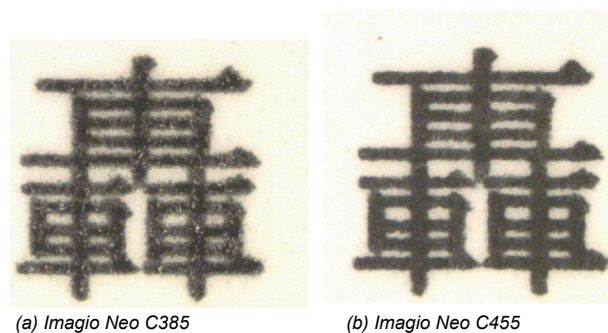


Figure 14. Comparison of line image (x15)

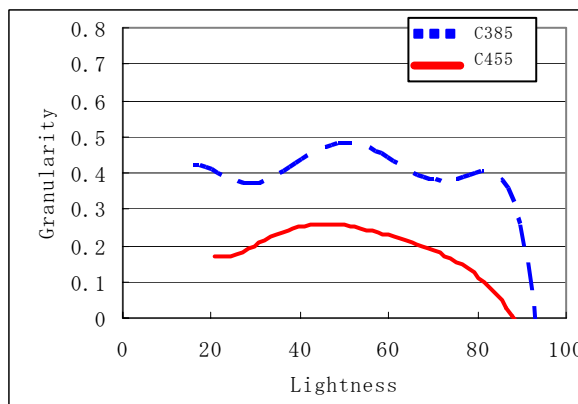


Figure 15. Comparison of granularity

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 14 and 15 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.

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. Also, it can reduce energy in toner's manufacturing process and toner consumption.

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)

Author Biography

Masumi Sato received his MA in applied physics from the University of Nagoya and joined Ricoh Company Ltd. in 1989. Since then he has worked in research and development section at Ricoh. In recent years, he has engaged in development color laser engine. He is a member of J. Imaging Society of Japan.