Toner Charge Distribution Change by Adding New Toner

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Abstract

Toner charge is significant in an electrophotographic printing process. The characteristics of toner charge depend on various factors such as charging method, charge control agents, and environment in two-component developer system. charge distribution is an important factor in toner and developing system. Toner charge distribution is affected by toner weight percent in two-component developer. Generally, the value of the average toner charge decreases when toner weight percent increasing. In this study, we have investigated the variation of toner charge distribution as the new toner is added for using two types of carriers such as ferrite carrier and carrier of the Imaging Society of Japan. According to the experimental results, the toner charge distributions are similar between toner added case after toner changed stationary state and ordinary toner charging case when toner is mixed with ferrite carrier. On the other hand, a clear difference of toner charge distribution is found by compared with previously cases when toner is mixed with STD carrier.

Introduction

Toner plays a very important role in the electrophotographic printing process [1-2]. Toner work as development, transfer and fixing processes in an electropthotographic printing. It has been recognized that both toner size distribution and the toner charge distribution ratio play a key role in good image quality. The characteristics of toner charge depend on various factors such as charging method, charge control agents, and humidity and so on in two-component developer [3-7]. Many studies have been carried out, however the mechanisms of the toner charge have not been understood clearly. Characterization of toners for their size and charge distributions or charge-to-mass ratio distributions has been carried out by a number of techniques. Some of the techniques used are Faraday cage or blow-off method electrostatic stripping of toners from carrier while the carrier is being agitated in a magnetic field, and electrical mobility spectrograph analysis. The previous techniques provide information on the average net electrostatic charge per unit mass based on the average particle size measured by microscopic analysis. The techniques are not suitable for the measurement of individual particle charge-to-mass ratio and cannot be readily used to analyze the toner particles for their bipolar charge distributions. Whereas, performance characteristics of a laser-based instrument called the electrical-single particle aerodynamic relaxation time (E-SPART) analyzer measures aerodynamic size and electrostatic charge distribution of particles in real time and on a single-particle basis [8]. As practiced in electrophotographic copier, the new toner is replenished to the development apparatus after developing process Thus, it is important to investigate the variation of toner charge distribution for the new toner adding. In this study, we compared with toner charge distributions between that in 10 wt% case and added to 10 wt% case.

Experimental

The photo of the toner used in the experiment by SEM is shown in Figure 1. The toner is made by pulverization and round treatment. The type of charging characteristic is negative. Two types of carriers are used in this experiment, such one is ferrite carrier (F150, Powdertech) and other is the standard carrier of the Imaging Society of Japan (N01). The SEM micrographs of them are shown in Figure 2 and Figure 3, respectively. The surface of carriers are concavity and convexity. In this experiment, the toner weight density starts of 3wt%. Then we the experiment, add a new toner to toner weight % 5. And then we add a new toner to toner weight % 7. At last, we add a new toner to toner weight % 10. As a comparison, toner charging starts of the condition toner weight % 5, 7, 10. The developers are mixed in a rotation cylinder with a rotating speed of 120rpm and the toner is charged by the contact with carrier. The mixing time is 10 min. Toner charge and size are measured using E-SPART analyzer (Hosokawa-Micron E-SPART type1 Improved model). The charge and the size of individual toner are measured simultaneously. Measuring mechanism of E-SPART is schematically shown in Figure 1. The toner particles are measured till 3000 counts on every mixing condition.

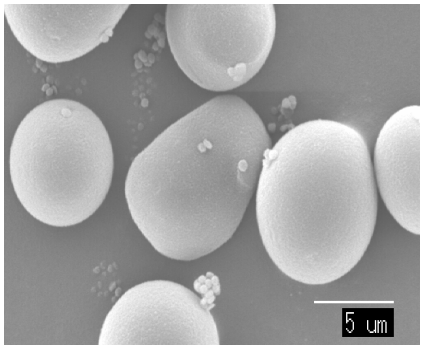

Figure 1*. SEM image of toner used in this experiment.*

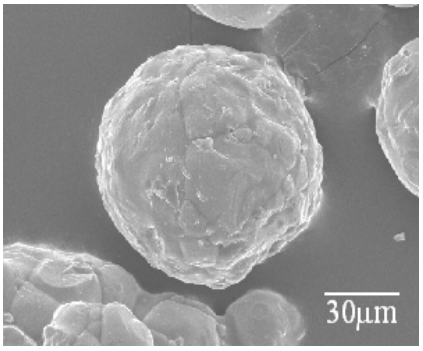

Figure 2*. SEM image of carrier (N1)*

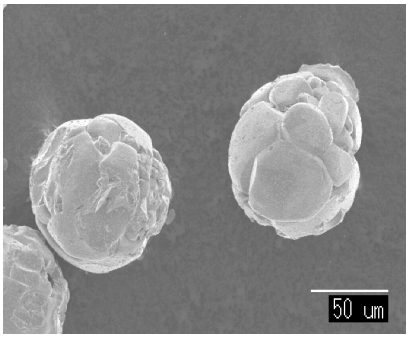

***Figure 3**. SEM image of ferrite carrier (F150)*

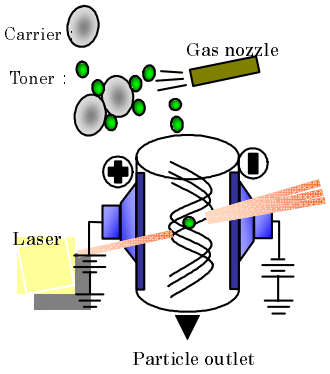

***Figure 4**. Measurement principle of an E-SPART analyzer.*

Results and discussions

The size distributions of toners are measured on different charging methods. The distributions are shown in Figure 5-7, respectively. The toner size distributions are approximately same, so the toner sampling conditions are possibly good.

The specific toner charge distributions are shown in Figure 8-11, respectively. It is found that the low charge toners are generated when the toner is added to certain stationary toner charged state. This is considered that newly added toner is not so easy to contact carrier, so newly added toner can not charge well.

The toner charge dependences on toner weight percent are measured on two type carriers and two charging histories. The specific toner charge dependences on toner weight % are plotted in Figure 12. It is found that the specific toner charge decreases as toner concentration increases in every case. When the medium charging ability carrier is used, the average specific toner charge shows nearly same dependence between two different charging methods. On the other hand, when the strong charging ability carrier is used, the average specific toner charge shows different dependence between charging methods. When toner is added from 3 weight % to 10 weight % by the step 2-3 weight %, the average specific toner charge is smaller than the value when toner is charged at 10 weight %. The reason is considered that toner is attached to carrier strongly when toner concentration is small and the newly added toner difficult to contact carrier and then little charged toner generated. It is confirmed from the difference between specific toner charge distributions of two different charging histories.

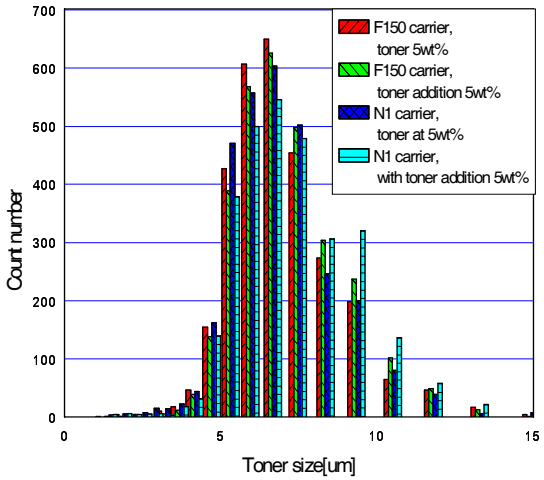

***Figure 5**. Toner size distribution at the toner 5wt%*

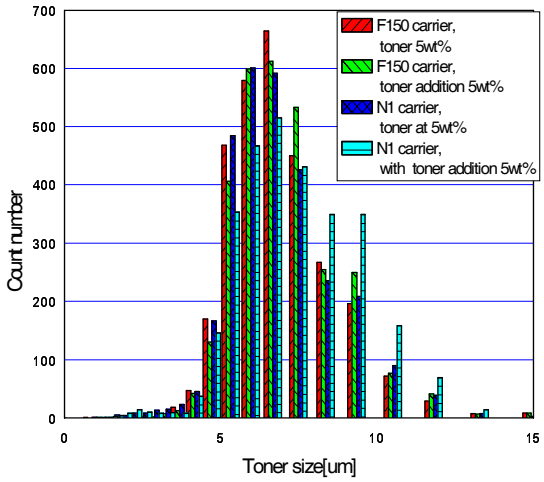

***Figure 6**. Toner size distribution at the toner 7wt%*

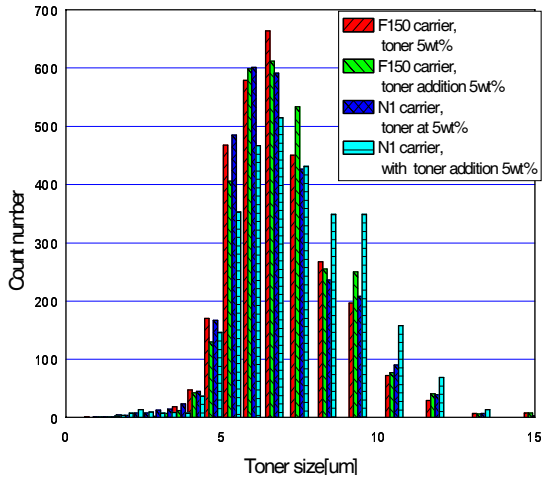

***Figure 7.** Toner size distribution at the toner 10wt%*

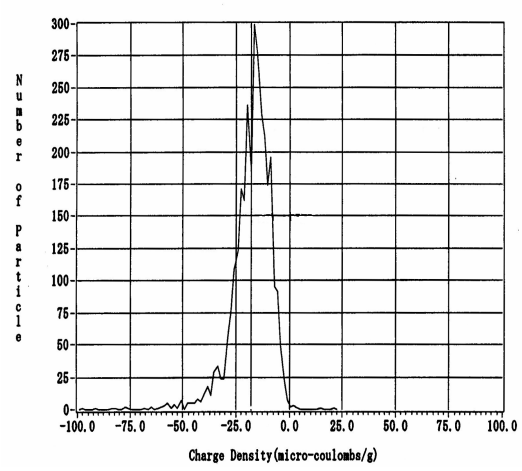

***Figure 8**. Specific toner charge distribution of F150 carrier, toner*

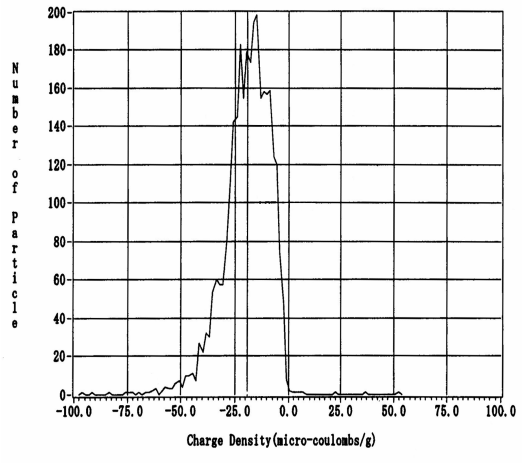

***Figure 9**. Specific toner charge distribution of F150 carrier, with toner addition 10wt%*

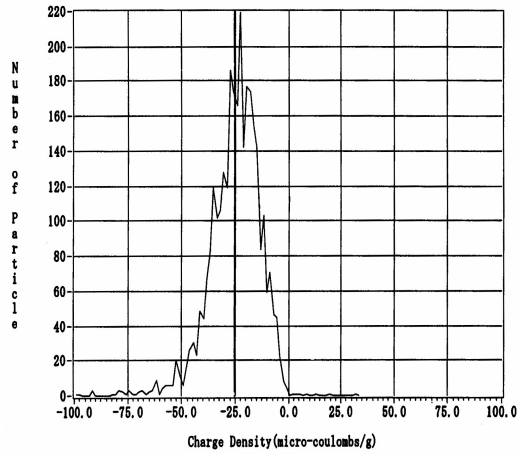

***Figure 8**. Specific toner charge distribution of N1 carrier,*

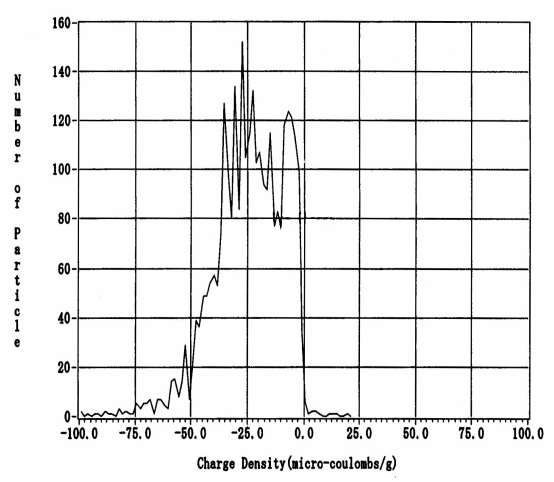

***Figure 11**. Specific toner charge distribution of N1 carrier with toner addition 10wt%*

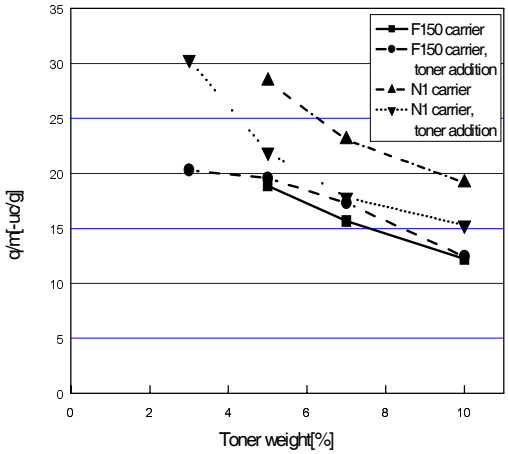

***Figure 12**. Average specific toner charge dependence*

Summary

Toner charge distributions are measured at various conditions. When the toner is charged by medium charge ability carrier, toner charge distribution is approximately same among the same toner concentration conditions, even if toner addition is carried out at the stationary charging state. On the other hand, when toner is charged by high charging ability carrier, low charge toner arises in the toner charge distribution after toner addition. It is proposed that the low charged toner arises because highly charged toners attach strongly to carrier and newly added toners become hard to contact carrier.

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