Effect of Charging Method and Toner Shape on Charging Characteristics of Mono-component Toner

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Abstract

Charging characteristics of two types of toners are carried out by two methods. One method is mixing with carrier and the other method is contact with developing roller and blade. To understand the charging mechanism, toner charging by two methods such as developer roller/blade charging and the carrier mixing charging is carried out, and toner charging characteristics of irregular shape toner and rounded toner are compared. Various factors such as toner material, toner manufacturing methods, toner shape, and charging method so on affect on toner charging characteristics. From the viewpoint of toner shape effect, toner charging characteristics are analyzed by E-SPART analyzer.

It is obtained that the toner charge dependence on toner size is 2.0th power of the size when toner is charged by carrier mixing, but the dependence is 1.3th power of the size when rounded /irregular toner is charged by roller/blade charging. It is also obtained that toner charge distribution of rounded toner is narrower than irregular shape toner.

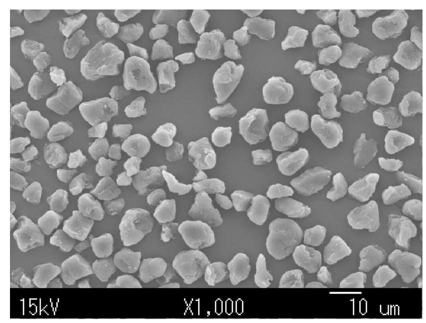
Introduction

Toner charge is essential in an electrophotographic printing process [1, 2]. The toner charge is controlled by various factors such as toner materials, toner shape, charging mechanism, and environmental conditions and so on. Toner charge gives a great influence to image quality in the electrophotographic printing. A lot of studies have been carried out for understanding toner charging mechanism. But the mechanism is complex and is influenced by many factors such as toner materials, charging conditions [3-5], humidity and so on. Toner shape is one of influential factor to toner charging [6, 7]. It is considered that the understanding of toner charging mechanism is not yet sufficient, including toner shape influence. In this report, toner charging mechanism is studied from the viewpoint of toner shape and toner charging mechanism. The specific toner charge is measured by E-SPART (Electrical Single Particle Aerodynamic Relaxation Time), which has characteristics of simultaneous measurement of toner charge and size [8]. Toner average charge dependence on toner size is estimated on toner shape and toner charging mechanism.

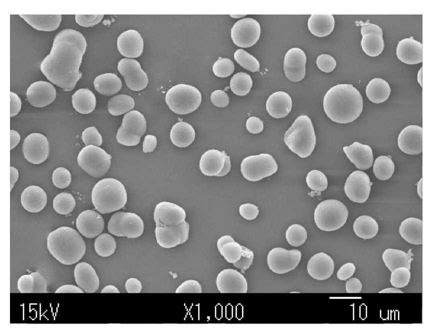
Experiment

The toners used in this experiment are made by pulverization method. The two types of toner are prepared. One is before rounded pulverized toner (toner-a) and other is rounded toner (toner-b) by rounding treatment. Photos of these toners are shown in Fig. 1. The rounded toner seems approximately spherical, but before rounded toner seems irregular shape. The size distributions measured are shown in Fig. 2. The size of toner before rounded is around 4.2 - 8.0um. The size of rounded toner is around 4.72-7.5um.

Toner is charged by two methods. One is charging method used in mono-component, in which toner is charged by contact with roller and blade as shown in Fig. 3, and other is charging method used in two-component, in which toner is charged by mixing with carrier as shown in Fig. 4. The charging by mono-component method is shown schematically in Fig. 3. Toner is charged by contact with roller and blade and tone on the roller is blow off to E-SPART measuring cell. The carrier used in this experiment is shown in Fig. 5. It is found that the surface of the carrier is wrinkled. The diameter of carrier is around 70um. The developer samples of mixture of toner and carrier are prepared at the conditions of 5 weight% of the toner. The developers are mixed in a rotation cylinder with a rotating speed of 120 rpm and the toner is charged by the contact with carrier. The mixing time is 10min. Toner charge and size are measured using E-SPART analyzer (Hosokawa-Micron E-SPART type1 Improved model).



(a)



(b)

Figure 1*. The SEM micrographs of toners used in this experiment, (a) before rounded pulverized toner (toner-a), (b) rounded toner (toner-b).*

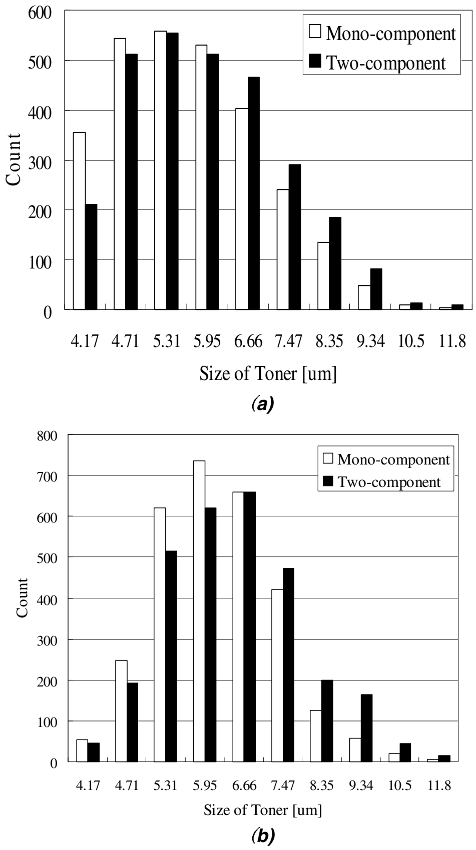


***Figure 2**. Histograms of sizes of toners, (a) before rounded pulverized toner (toner-a), (b) rounded toner (toner-b).*

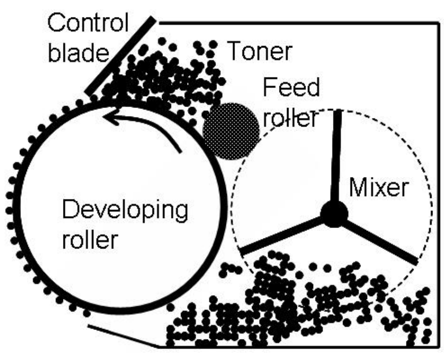


***Figure 3**. A mono-component toner charging method.*

The charge and the size of individual toner are measured simultaneously. The toner particles are measured till 3000 counts on every mixing condition.

Results and discussions

The size distributions of two type toners are measured on two different charging methods. The distributions are shown in Fig. 2. The sizes of toner-a and toner-b are distributed around 4.17 - 8.35um and 4.71- 7.47um, respectively. It is found that toner-a contains smaller size in the distribution. Concerning the charging method, the distribution change by charging method is little. So, it

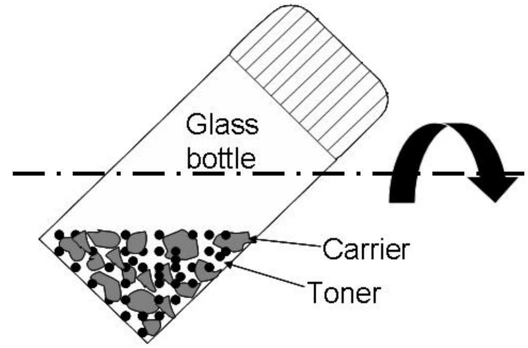


***Figure 4**. A two-component toner charging method.*

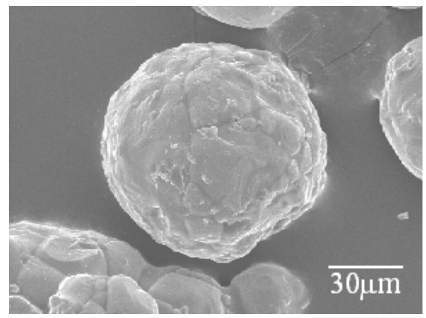


***Figure 5**. A SEM micrograph of a carrier used in this experiment.*

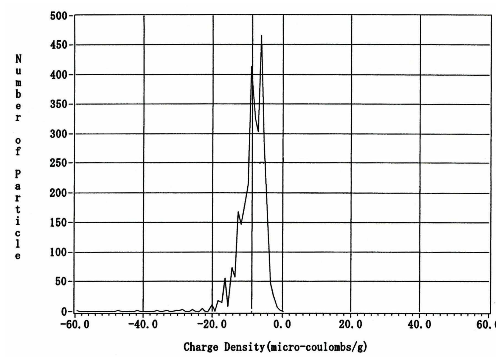


***Figure 6**. A histogram of charge-to-mass ratio q/m of toner-a used in mono-component charging method.*

is considered roughly that the measuring is carried out in a good condition.

The specific toner charge distributions are shown from Fig. 6 to Fig. 9, respectively. It is found that the charge distributions depend greatly on the charging methods. When the toner is charged by mixing with carrier, toner is charged high compared with the toner charge by roller/blade charging. The difference is from materials and contact conditions. Concerning the toner shape difference in roller/blade charging, the specific charge distribution of toner-b (spherical) is seems to be narrower than toner-a.

As a one of criteria of distribution, comparison between average of (q/m) and (total q)/(total m) is carried out. The ratios of average of (q/m) and (total q)/(total m) are estimated as 1.5 (toner-a) and 1.3 (toner-b). It is obtained that the ratio of the rounded toner shows smaller value than irregular toner. It is considered that

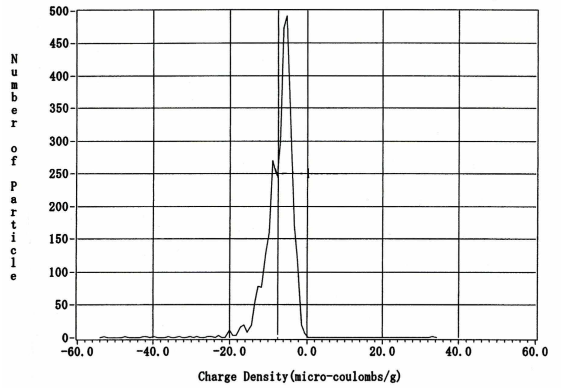


***Figure 7**. A histogram of charge-to-mass ratio q/m of toner-b in mono-component charging method.*

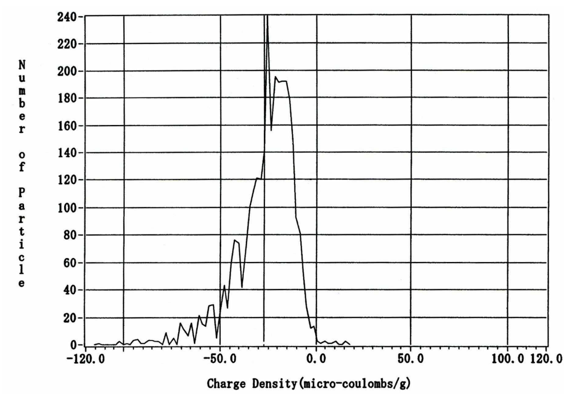


***Figure 8**. A histogram of charge-to-mass ratio q/m of toner-a in two-component charging method.*

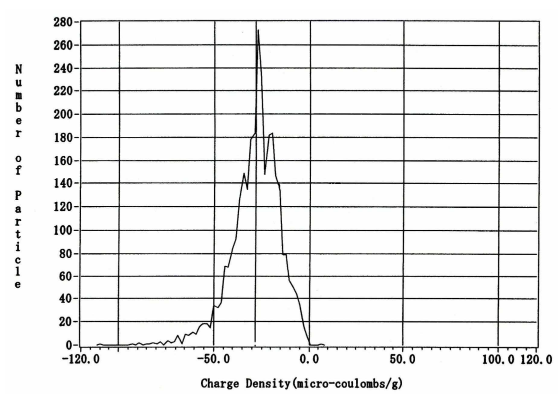


***Figure 9**. A histogram of charge-to-mass ratio q/m of toner-b in two-component charging method.*

the rounded toner rolls between roller and blade and charged better than irregular shape toner.

The toner charge dependences on toner size are measured on two type toners and two charging methods show in Fig. 10 and Fig. 11, respectively. When toner is charged by mixing with carrier, toner charge increases as 2.0th power of toner size (toner-b) and 1.6th power of toner size (toner-a). The spherical toner contact well with carrier, so toner charge behaves as square of toner size. When toner is charged by roller/blade contact, toner charge

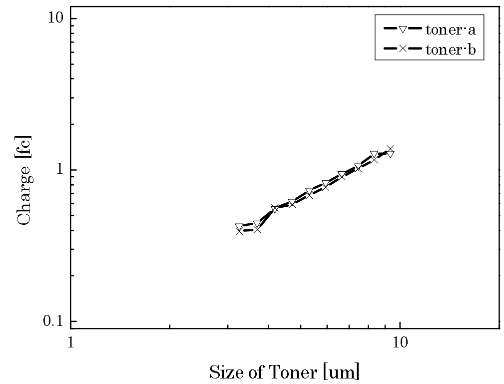


***Figure 10**. Toner charge dependence on toner diameter in mono-component charging method.*

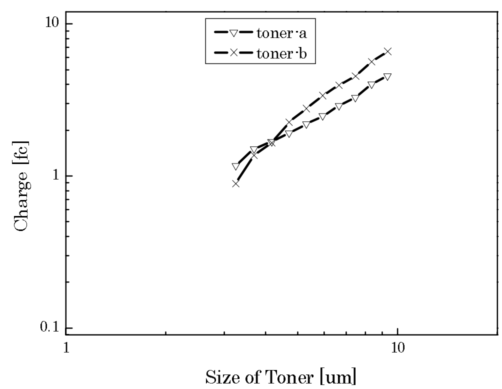


***Figure 11**. Toner charge dependence on toner diameter in two-component charging method.*

increases as around 1.3th power of toner size. This is because toner contacts roller/blade not very well as carrier mixing.

Summary

The difference between mono-component charging and two-component charging are investigated on two types of toners of rounded toner and before rounded toner. When toner is charged by mixing with carrier (two-component), the charge of rounded toner shows square dependence against toner size, however, the charge of before rounded toner shows less than 2.0th power of toner size.

When the toner is charged by roller charging (mono-component), toner charge increases as 1.3th power of toner size in both shapes of toner. However, concerning the specific toner charge distribution, the rounded toner shows narrower distribution than the before rounded toner.

It is considered that the rounded toner contacts roller/blade better than irregular toner, so the rounded toner shows narrower distribution.

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