

# The Effect of Toner Mixing Method on Toner Charging Characteristic

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## Abstract

*Toner tribocharging characteristics are affected by various factors: charging method, materials, environment and others. The toner charge stability plays an important role for improving an electrophotographic image quality. Surface state of toner acts a key factor to affect the toner charge stability. In this study, aerodynamic size and electrostatic charge distribution of the toner particles are measured individually by E-SPART (Electrical Single Particle Aerodynamic Relaxation Time) analyzer. The effect of toner charge of mixing method in several toner concentrations has been investigated. Two kinds of toners show different toner tribocharging characteristics when mixed by two mixing methods. One kind of toner shows stable tribocharging characteristics in both two mixing methods. Whereas, another one shows less tribocharging characteristic level by mixed a paint shaker than that by mixed a rotation cylinder. The stability of surface state of toner gives a great influence to the tribocharging characteristics. The deterioration of the tribocharging characteristics level is considered caused by the degradation of the toner and/or carrier. It is inferred that The CCA particle and external additive break away increasingly from the toner surface by paint shake, and causes deterioration of toner tribocharge level.*

## Introduction

Toners for developing process are conventionally produced by melt kneading of a colorant, wax, resin charge control agent (CCA) and others, and particles obtained through pulverizing and classifying processes. Generally, CCA particles exposed on the toner surface through the pulverizing process play a key role when the toner contact with carrier [1-3]. During the contact, charge transfer occurs at the interface between the toner (or CCA particle) and carrier. It has been reported that the CCA particles remove between toner particles and carrier particles in the tribocharging process, and affect toner charging level and polarity [4-5]. And it is also reported that assumes an appreciable temperature increase at the “toner/carrier” contact due to tribo-electrification, the local temperature at the “toner/carrier” interface amounts to at least 100 degrees C, the temperature dependence of the electrical conductivity of CCA [6]. The toner flowability, charging stability and promptness are required for the toner developing process. Toner shape is becoming an increasingly significant factor to

affect the toner charge [7-9]. However, maintaining a toner surface state such as keeping exposed on the toner surface CCA is also an important problem. In this study, we have discussed the tribocharging characteristics of two kinds of pulverized toners by two mixing methods such as paint shaker and rotation cylinder in several toner concentrations. The specific toner charge and toner size distribution are measured by E-SPART (Electrical-Single Particle Aerodynamic Relaxation Time) analyzer [10, 11], which measures the aerodynamic size and electrostatic charge distributions of particles suspended in air by using a laser.

## Experiment

It is said that electrical charge transfer occurs by contact of the surfaces of two dissimilar materials. In this experiment, the toner charge was occurred by two-component developing method which toner is charged by mixing with carrier. Two kinds of pulverized toners (M1 and M2) were used in this experiment. The size of toner (M1) is around 4.5-7.5 $\mu$ m. The size of toner (M2) is

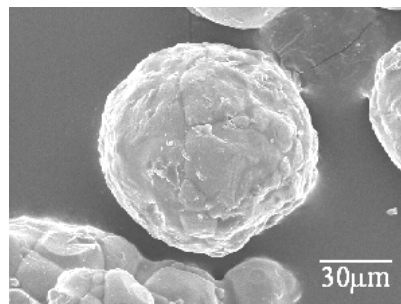


Figure 1 SEM micrograph of the standard carrier of the Imaging Society of Japan.

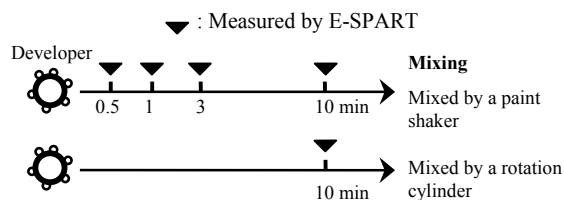


Figure 2 The experimental procedure.

around 4.0-8.0 $\mu$ m. Figure 1 shows the SEM micrograph of carrier which is the standard carrier of the Imaging Society of Japan. The standard carriers have a narrow sizes distribution, and have a spherical shape. The toner charging capability of the standard carriers are stable with time and able to apply a small size toner [12]. The surface of the standard carrier looks wrinkled. The average diameter of the standard carrier is approximate 80 $\mu$ m.

Toner concentrations as the two-component developer were varied at 3wt%, 5wt% and 7wt%. Each developer 20g of the certain toner weight concentration was poured into a 50cc glass bottle. The prepared developers had been kept at 20 degrees C, 60%R.H. above 24hours before measurement occurred, in order to obtain a good measurement condition of toner. Developers were mixed by a paint shaker (5410 one-gallon paint shaker, made in Red Devil Equipment Co.). Sizes and charge of toner of developer were measured by using E-SPART analyzer (Hosokawa-Micron E-SPART type1 Improved model) during the mixing period at 0.5min, 1min, 3min and 10min. The experimental procedure is shown in Figure 2. Whereas, other developers mixed by a rotation cylinder with a rotating speed of 120 rpm for 10min were also measured by E-SPART analyzer. The toner particles were measured till 3000 counts in each measurement.

## Results and discussion

Figures 3-5 show the relations of a specific toner charge and the mixing time at toner concentrations 3wt%, 5wt% and 7wt%, respectively. The specific charge of toner (M1) decreases from the paint shaking time at 0.5min at each toner concentration except at 5wt%, the specific toner charge decreases from paint shaking 1minute. All specific toner charges mixed by a paint shaker for 10min were lower than that mixed by a rotation cylinder at three toner concentrations cases. It is clear that a low level of CCA and external additive can have a major effect on toner charging level, when they are directly applied to the toner surface. The decrease of the specific toner charges is deduced caused by the surface deterioration of toner and carrier. For the stronger friction, the CCA and external additive are broken away from the toner surface, and some detached CCA and external additive are reattach on the carrier surface caused the charging ability of carrier deteriorate, especially at the higher toner concentration 7wt%. Whereas, toner (M2) mixed by a paint shaker shows a stable charging ability at low toner concentrations 3wt% and 5wt%. It is considered that the stability of surface state of toner (M2) is better than toner (M1). It is found that a specific toner charge mixed by a paint shaker for 10min was higher than that mixed by a rotation cylinder at 3wt%. The higher specific toner charge is considered that developer mixed by a paint shaker can obtain more rubbing. At high toner concentration 7wt%, the toner (M2) charge level decreased as paint shake time increases. It appears similar to M1, the contamination of carrier causes the deterioration of the charging ability. The toner charge variations dependence on toner size are shown in Figure 6, respectively. It is considered that the increase of the toner charge is proportional to square of the toner size with effective rubbing. The charging ability of toner (M1) in big size area is deteriorated as paint shake time increase at toner concentration 5wt% and 7wt%. Whereas, the charging ability of toner (M2) in big size area is just deteriorated by paint shook 10min at 7wt%. It is inferred that the deteriorations of charging

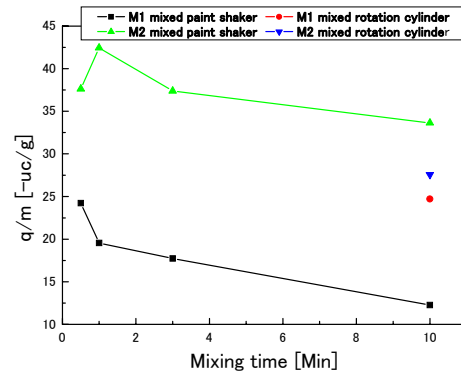


Figure 3 Specific toner charge dependence on mixing time at toner concentration 3wt%.

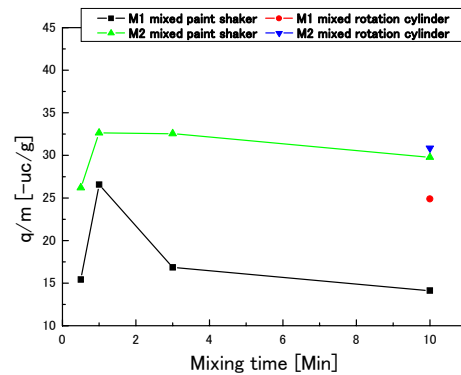


Figure 4 Specific toner charge dependence on mixing time at toner concentration 5wt%.

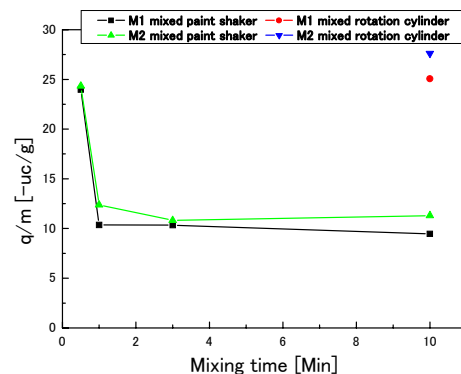
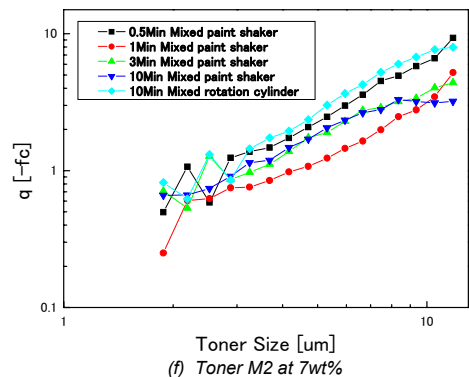
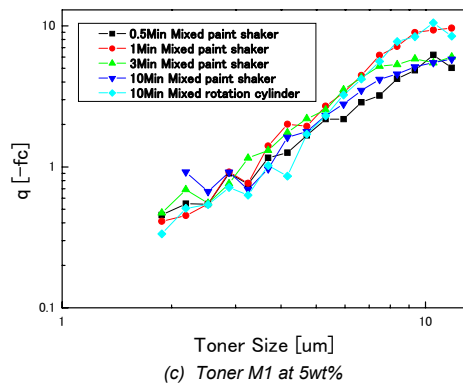
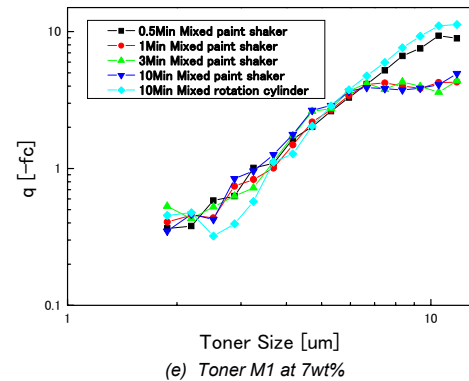
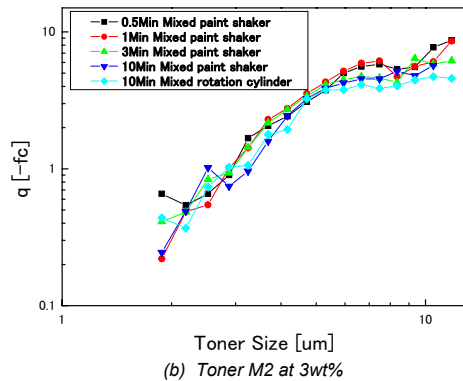
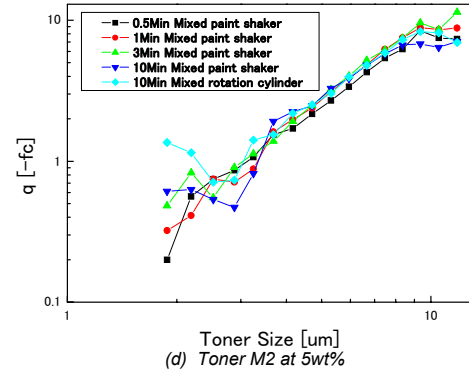
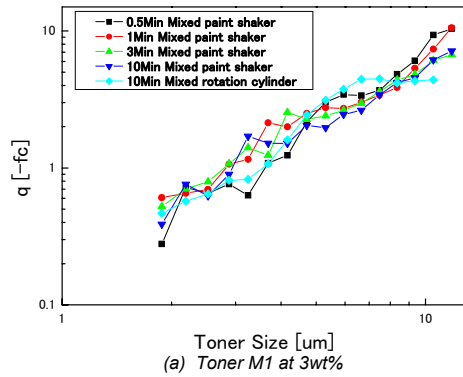


Figure 5 Specific toner charge dependence on mixing time at toner concentration 7wt%.

level are due to the CCA and external additive broken away from the toner surface. In the big size area of toner, the CCA and external additive are broken away increasingly from the toner surface dependence on paint shake time.



## Conclusions

The different charging characteristics of two kinds of pulverized toners mixed by a paint shaker or a rotation cylinder at toner concentration 3wt%, 5wt% and 7wt% were investigated. One kind of toner appears a stable tribocharging characteristic in the low toner concentration when the developer is mixed by paint shaker or rotation cylinder. Another one shows an unstable tribocharging characteristic when developer is mixed by a paint shaker. The charging ability of toner is deteriorated by paint shaking. It is inferred that the CCA and external additive are broken away from the toner surface, especially, from the surface of the big size of toner, the CCA are broken away increasingly. So the stability of the toner surface state plays a key factor to the toner tribocharging ability. At the high toner concentration, two

**Figure 6** Toner charge dependence on toner size at several toner concentrations.

kinds of toners appear deteriorated tribocharging level together. It is inferred that the contamination of carrier causes the deterioration of the toner charging ability.

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