Charging Characteristics of Polymerized and Pulverized Toner in the Roller Rotation Mixing System of Toner and Carrier

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Abstract

Toner charge is very important in electrophotographic printing process. Although many studies on toner charging have been carried out, the process is very complex and the understanding of toner charging characteristics is not yet sufficient. In this paper, toner charge distribution is measured by E-SPART (Electrical Single Particle Aerodynamic Relaxation Time) analyzer, which can measure the size and charge of toner. The measured toners are polymerized and pulverized type. Charging is carried out as follows : the toner is mixed with the carrier and the mixture is bottled into the roller, and mixed by rotating the roller. Toner charge dependences on toner wt% are compared between polymerized and pulverized toner.

Introduction

Toner charge is very important because it gives great influence to image quality in electrophotographic printing.[1,2] A lot of studies have been done for high quality image and wide stability. Toner charge characteristics are influenced by many factors such as toner materials, charging conditions,[3-5] humidity and so on. Concerning the toner charge measuring method, several methods have been proposed and are used.[6] Among them, E-SPART is a powerful method, because toner charge and toner size can be measured simultaneously.[7]

Measuring mechanism of E-SPART is schematically shown in Fig. 1. Toner is blows off from carrier to measuring cell. The toner motion in the application field of electric field and sonic wave is measured by laser doppler effect.

The distribution extent of toner charge has a significant effect on print quality. It is therefore important to obtain the extent of the toner charge distribution.

In this paper, the size and charge of pulverized and polymerized toner are measured. The characteristics of toner charging are examined on the roller rotation mixing system of toner and carrier. In addition, toner charging mechanism are discussed on pulverized and polymerized toner.

Experimental

The toners used in this experiment are made by pulverization method and polymerization method. The both toners are adjusted to a negative charging type by CCA (Charge Control Agent) and the flow property is controlled by silica treatment. The carrier is made of steel and the diameter is around 60-120 μm. The developer sample of pulverized and polymerized types is prepared on the conditions of 1-7weight% of the toner. The developers are mixed in a rotation cylinder with a rotating speed of 120 rpm and the toner is charge by the contact with carrier. The mixing time is 10 min.

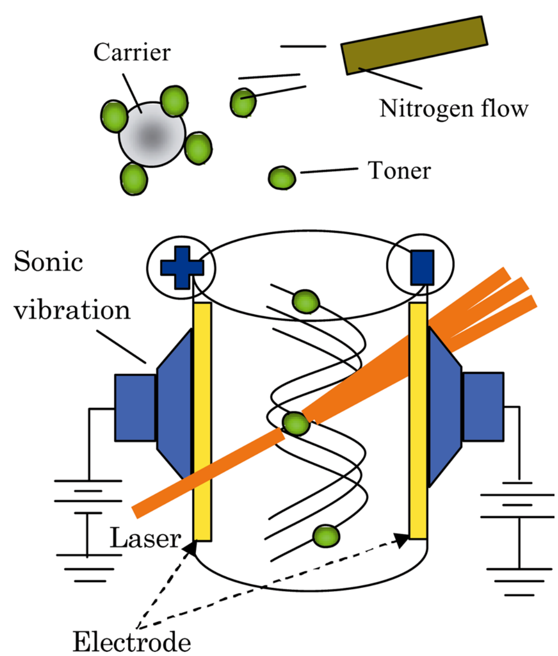

Figure 1. Schematic diagram of measuring cell of E-SPART analyzer.

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. The toner particles are measured till 3000 counts on every mixing condition.

Results and Discussions

Photographs of toners and carrier observed by SEM are shown in Figs. 2, 3 and 4.

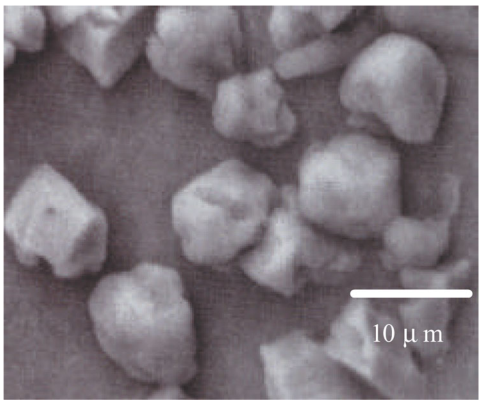

Figure 2. SEM image of pulverized toner.

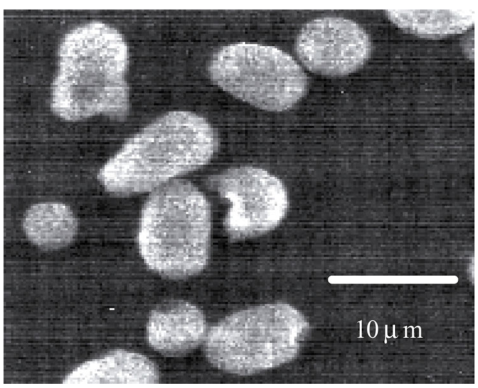

Figure 3. SEM image of polymerized toner.

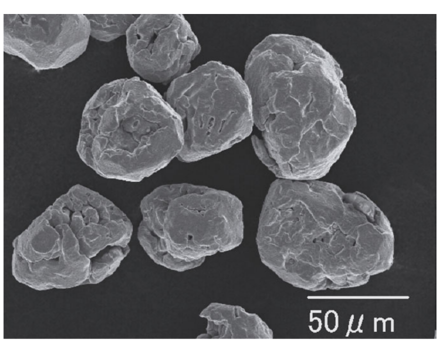

Figure 4. SEM image of carrier.

It is found that the pulverized toner shape is irregular. On the other hand, it is found that the polymerized toner shape is round. Concerning the carrier, it is found that the surface of the carrier is wrinkled. The histograms of toner diameter are shown in Figs. 5 and 6.

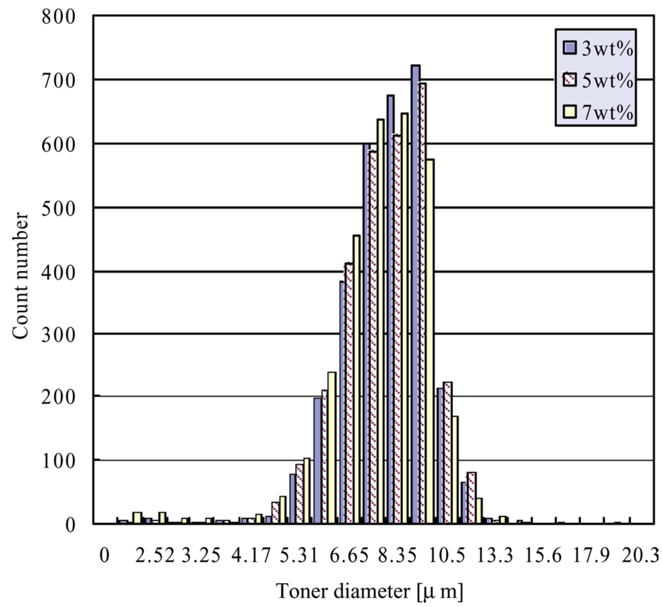

Figure 5. Histogram of pulverized toner diameter.

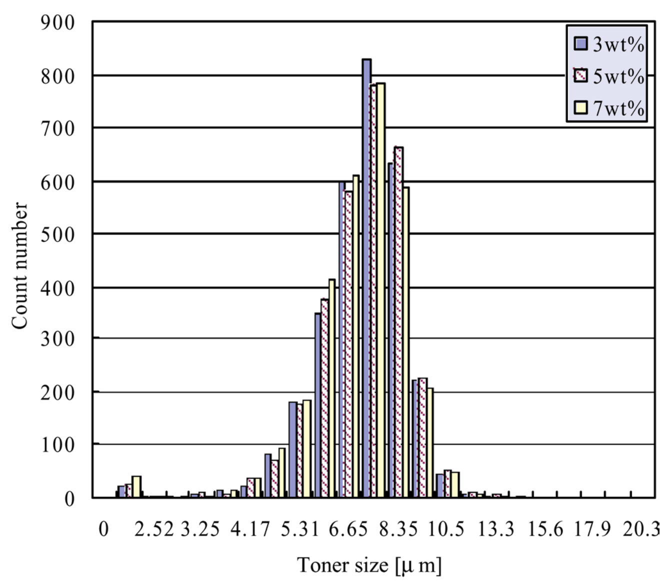

Figure 6. Histogram of polymerized toner diameter.

The diameter measured by E-SPART is aerodynamic diameter. It is found that the diameter of pulverized toner and polymerized toner are distributed from 5 to 9 μm. The peak of polymerized toner is a little bit higher. This result is considered that the toner diameter distribution of polymerized toner is more sharp. The histogram of toner diameter seems to be independent of the toner weight%. This suggests that the sampling of the toner from the carrier is carried out in a good condition in this measurement.

Next, the relation of a specific toner charge and the toner weight % are shown in Fig. 7.

For the pulverized toner, it is found that the specific toner charge decreases as the toner weight% increases. However, it is found that the specific toner charge of the polymerized toner is nearly constant between 1wt% and 4wt%, and decreases more than 5wt%. It is considered that the difference of the tendencies is from the shape of two toner types . It is inferred that the polymerized toner is easy to roll because the polymerized toner is more round than the pulverized toner. Therefore the almost surface of the polymerized toner contacts with carrier and is charged till the carrier covered by toner. The decrease in more than 5wt% is due that excess toner from single layer on carrier arises. The q/m histograms of the pulverized and the polymerized toners are shown in Figs. 8 and 9.

For the pulverized toner, q/m histogram shifts to low q/m value side, as the toner wt% increases. For the polymerized toner, q/m histogram have two types: one is high q/m value histogram and another is low q/m value histogram. The carrier is covered by toner around 5wt%, high q/m is inferred to correspond to the single toner layer on the carrier, and low q/m is due to excess toner from single layer. The inverse of specific toner charge is shown Fig. 10.

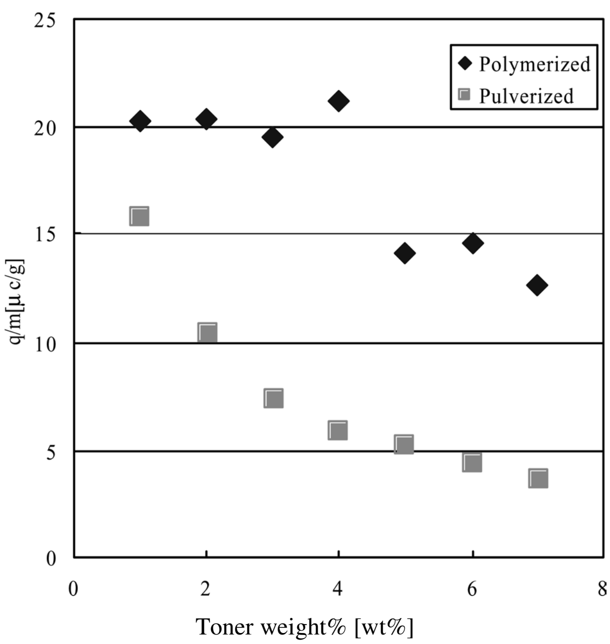

Figure 7. Specific toner charge dependence on toner weight%.

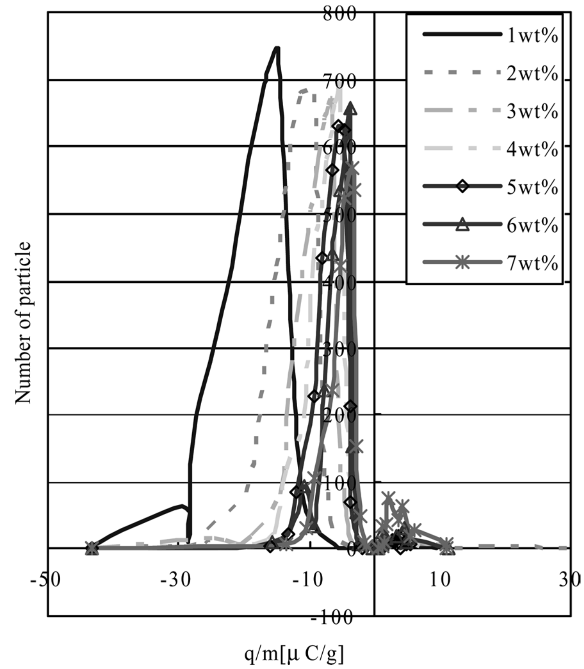

Figure 8. q/m histogram of pulverized toner.

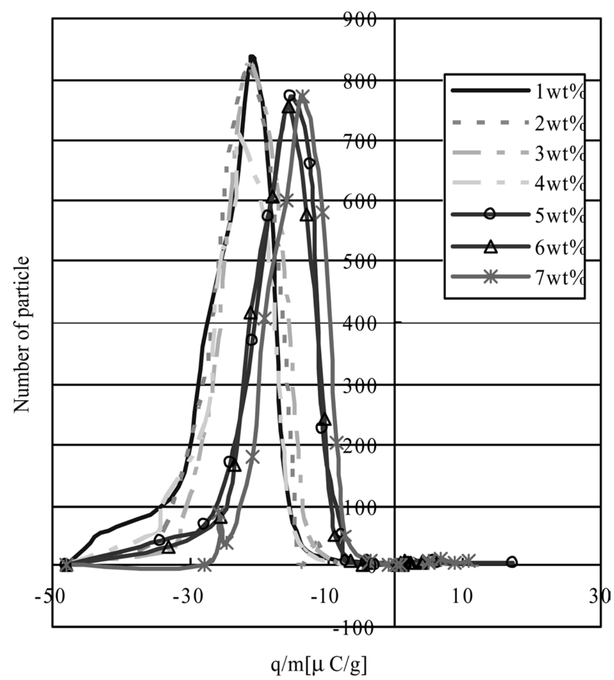

Figure 9. q/m histogram of polymerized toner.

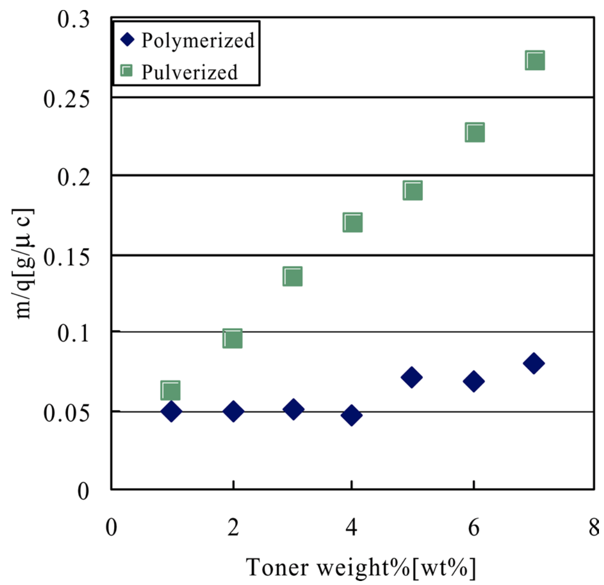

Figure 10. Inverse specific toner charge versus toner weight%.

It is found that m/q of the pulverized toner increases linearly. The linear relation suggests the possibility of application of surface states theory.

Conclusions

The charge and size of individual toner is measured using E-SPART analyzer. It is found that the specific toner charge decreases as the toner weight % increases in the pulverized toner. On the other rand, it is found that the specific changes of the polymerized toner do not show clear change tendency in the range of 1wt%-4wt% and show clear decrease tendency more than 5wt%. Concerning the plotting of inverse specific toner charge versus toner wt%, the pulverized toner shown linear relation, but the polymerized toner has not such a relation.

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