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Dependence of Toner Charging Characteristics on Amount of CCA Addition

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Abstract

Toner charging is important in developing process and is controlled by various factors. CCA (Charge Control Agent) has strong effect on charging characteristics. Toner charge is measured by changing the CCA addition amount. It is found that saturation charge increases and the time constant of charging up decreases with the increase of CCA addition amount. It is discussed that charging model explains these characteristics.

Introduction

Toner charging is an important factor in electro-photographic printing process. The toner charging is controlled by toner materials including several additives and charging mechanism of developing unit. Toner image is formed by electrostatic force worked on charged toner, so it is important to control toner charge within adequate value. Toner charging mechanism has been studied extensively for long time from the various viewpoints[1-5]. But, the understanding of charging mechanism by CCA (Charge control Agent) is not enough. The purpose of this paper is to obtain deeper understandings of toner charging mechanism experi-mentally. The dependence of charging characteristics on CCA weight % is obtained by using the measuring methods of blow off and E-SPART.[6,7] The charging characteristics and the difference in measuring method are discussed.

Experimental

The toner used in this experiment is; base material: polyester resin, diameter: around 9 micron meter (Volume diameter: 50%), CCA: Cr complex salt, surface additives: silica size (diameter: 10-15nm), manufacturing method: crushing.

The toner names and its additives (CCA type, CCA wt %, and silica wt %) are shown in Table 1.

Table.1. Toner name and its additives.

Toner name	CCA type	CCA wt%	Silica wt%
KT-04a		0	0
KT-05a	A	1%	0
KT-06a	A	2%	0
KT-07a	A	3%	0
KT-04b		0	1%
KT-05b	A	1%	1%
KT-06b	A	2%	1%
KT-07b	A	3%	1%
KT-11b	B	0.25%	1%
KT-12b	B	0.5%	1%
KT-13b	B	1%	1%
KT-14b	B	2%	1%
KT-15b	B	3%	1%

The differences of CCA type A between type B are number of Cl substitution (type A: 2, type B: 1) and molecular weight (type A < type B). The toner charging is carried out by mixing method as shown in Fig.1. The diameter of aluminum pipe roller is 28mm (inside) and its rotation speed is 120rpm. Mixing ratio is: carrier 19g and toner 1g. Charge amount of toner is measured by blow off method as shown in Fig. 2. Blow off is realized by using vacuum cleaner. The separation of toner and carrier is separated by stainless steel mesh #500.

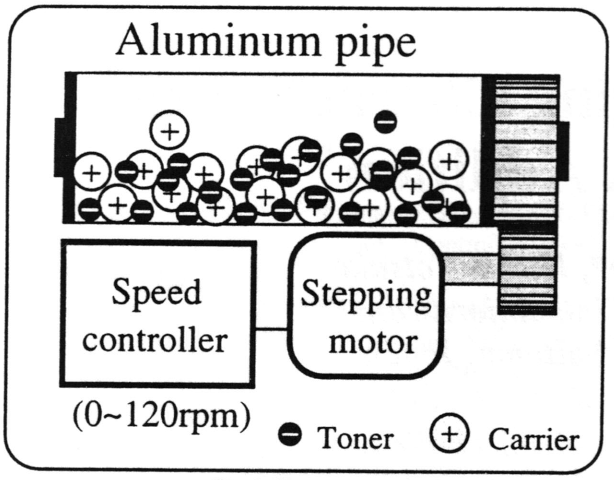


Fig.1.Charging method.

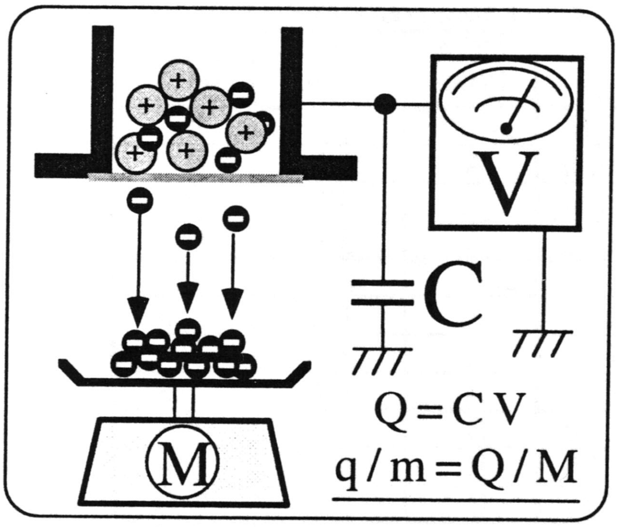
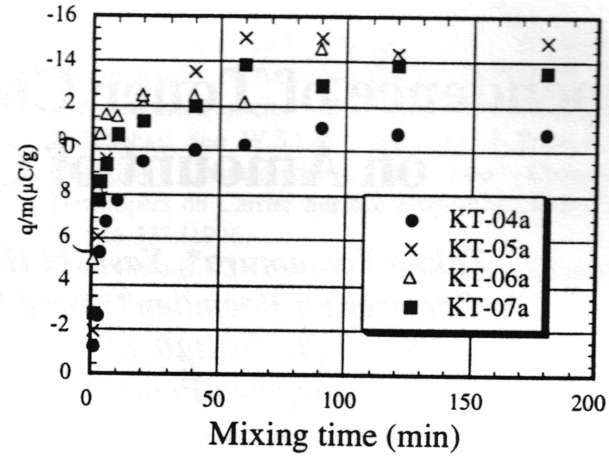


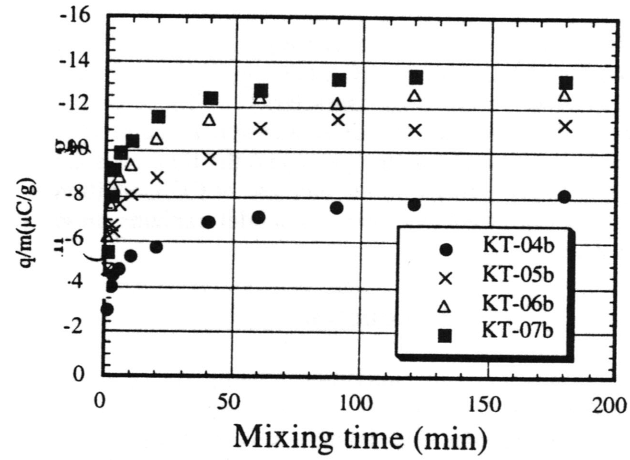
Fig.2. q/m Measurement method.

Results and discussions

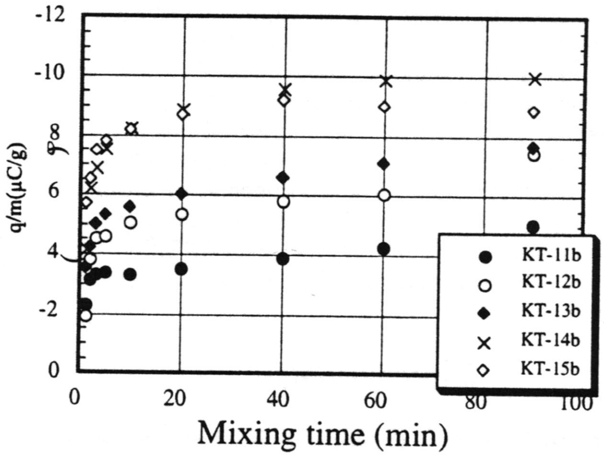
The dependencies of q/m (toner charge amount/toner mass[coulomb/g]) on mixing time are shown in Fig. 3. It is observed that the values q/m increase with the mixing time. We can recognize that the saturation value of q/m is influenced by silica, CCA type and its wt %. From the comparison of Fig. 3 (a) between (b), it is found that silica has effects of decreasing the saturation q/m values and the scattering of the measured q/m values. Silica has the abilities of making toner charge positive and also of making toner flow smooth. From the comparison of Fig. 3 (b) between (c), the q/m saturation value of CCA type B shows smaller value than the value of CCA type A. CCA type B is weaker charging ability than CCA type A, because its number of replacement of Cl is fewer and the molecular weight is larger. So, it is thought reasonable result. Figure 3 shows the value q/m increases with the increase of CCA wt%. The relation of q/m versus CCA wt % is not linear and saturates.



(a) KT-04a, KT-05a, KT-06a, and KT-07a (CCA type A, no silica)



(b) KT-04b, KT-05b, KT-06b, and KT-07b (CCA type A, silica)



(c) KT-11a, KT-12a, KT-13a, KT-14a and KT-15a (CCA type B, silica)

Fig.3. Dependencies of q/m on mixing time.a

The charging time of 70% of saturation value is shown in Fig. 4. It is found that the time constants decrease with the increase of CCA wt %.

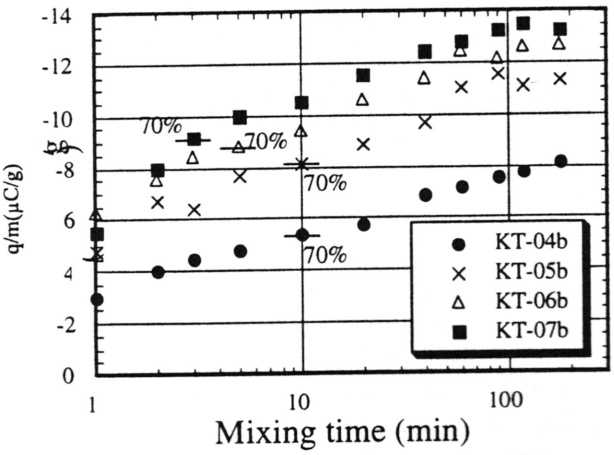


Fig.4. Charging time constant dependence on the additive amount of CCA.

E-SPART analyzer has characteristics of obtaining both data of charge amount and diameter of each toner. To check the reliability of the data, we compare the q/m data of two methods: E-SPART and Blow off. The data are shown in Table 2. The q/m values by two methods agree well. So, these measurement methods thought to be reliable.

The measured results of toner names KT-07band KT-04b are shown in Fig. 5.

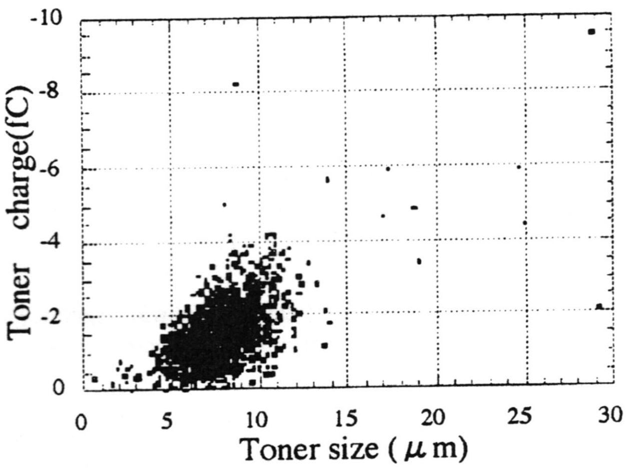
Charge amount of toner has roughly second order dependence on the diameter of toner. It is observed that the CCA addition has an effects on shifting the charge distribution of toner to higher charge. We define contact charging equilibrium electric field Ecce, which is the equilibrium electric field at contact point. The electric field Ecce depends on CCA, resin, silica and conditions such as humidity. Saturation charge of toner q_s is expressed,

$$q_s = 4\pi^2 \, \text{Ecce} \qquad (1)$$

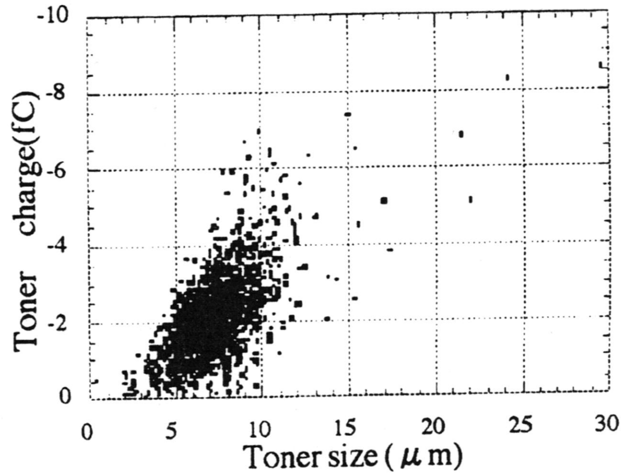
where ε is the dielectric constant of air and r is the radius of toner. These results show no contradiction to above mentioned experimental results.

Table 2. Comparison between E-SPART and Blow off data.

Toner name	KT-04b	KT-07b
Blow off (μ C/g)	-4.25	-9.35
	-4.24	-9.19
E-SPART (μ C/g)	-3.99	-7.58
	-4.56	-7.60
Mixing time (min)	90	90
Temperature (°C)	22	22
Humidity (%)	43	43



(a)KT-04b (CCA type A,silica)



(b)KT-07b (CCA type A, silica)

Fig.5. Distribution of toner charge and toner diameter measured by E-SPART analyzer.

Summary

The toner charging characteristics are measured on various weight % of CCA amount. Two types CCA which charging strength is different are used. In the both type of CCA, q/m of toner shows saturation with the increase of CCA weight %. Charging is controlled by the balance of CCA charging strength and electric field of toner surface. The comparison of two measuring methods of blow off and E-SPART is carried out. The charging model and the comparison are useful in understanding developing mechanism.

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