

Toner Charging in Developing Process

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Abstract

Toner charge is important in developing process of electrophotography. Toner is charged by contact with carrier (or developing roller). Toner charge when toner moves to photoreceptor is essential in developing. On mono-component roller developing system, toner charges on roller of before developing zone, on photoconductor, and on roller after developing zone are measured, respectively. From the measured toner charges, the toner re-charging mechanism in developing process is discussed.

Introduction

Electrophotography is used widely from home to office, print shop and is now very important technology. Electrophotographic printing process consists of several processes. Developing is one of most important process for controlling print quality, device size, maintenance and so on. It is very complex system and numerous studies on the developing process have been carried out from various viewpoints [1-6]: toner charging mechanism, toner material, CCA effect on toner charge, and developing mechanism and so on.

But, understanding of developing process is not enough yet, and further studies are needed to get guideline of designing developing unit. To understand the developing process more, we measured toner charge at the several points of developing process. We try to advance the understading of developing process on the viewpoint of toner charge.

Experiments

Figure 1 shows cross section of developing unit used in this experiments.

Toner is mixed by supply roller and is conveyed to developing roller. The toner conveyed to the developing roller is regulated by metal blade and charged by frictional contact with the blade and the developing roller. Toner layer contacts with photoreceptor and some toners move to photoreceptor by electric force, then toner image is formed on the photoconductor.

Toners prepared for this experiments are classified to two types: crushed type and polymerized type. Crushed toner is 4 species and polymerized toner is 2 species. Shape of crushed toner is irregular and shape of polymerized one is spherical. These toner's diameter is distributed around 7 to 10 micron meter.

The specific charge of toner is measured by the so-called blow off method. After toner is charged by mixing with toner, suction type is applied and toner is separated by metal mesh #500. When toner is charged in developing unit, toner is removed by suction force generated by vacuum cleaner and is caught by fine filter (3M, G150). Unbalanced charges are measured by electrometer and the weight of toner in the filter is measured by balance. In both cases, the measured charge is divided by weight of toner and specific charge of toner q/m is calculated.

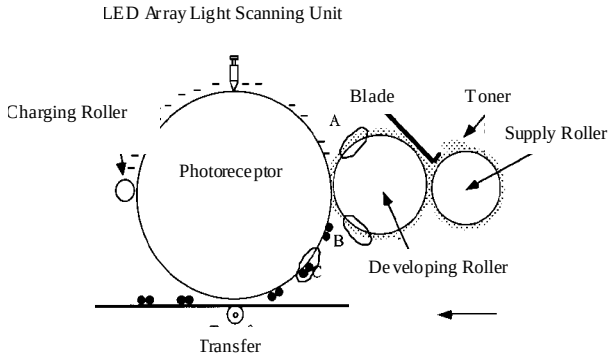

Figure 1. Cross Section of Printing Mechanism. A: before development, B: after development, C: developed image,

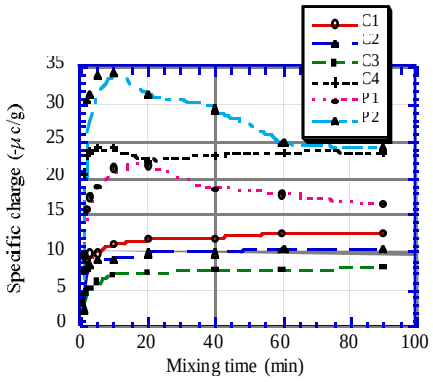

Figure 2. Charging characteristics of 6 toners

Results and Discussions

Figure 2 shows the characteristics of toner charging by rotating cylinder[5,7]. Specific charge of toner increases with charging time. Polymerized toner shows higher specific charge than crushed toner. Charge of polymerized toner shows maximum value and then decreases. The decrease is thought because CCA of toner transfers to carrier.

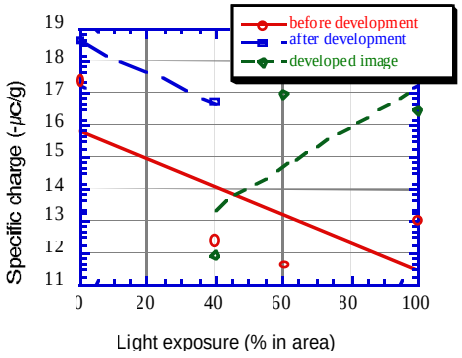

Figure 3.1. Dependency of specific charge on light exposure (a) C1

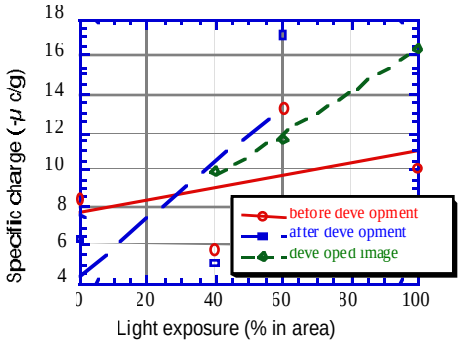

Figure 3.2. Dependency of specific charge on light exposure (b) C2

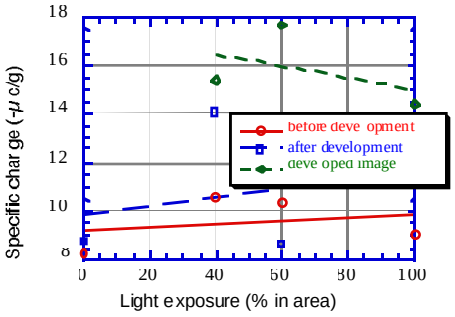

Figure 3.3. Dependency of specific charge on light exposure (c) C3

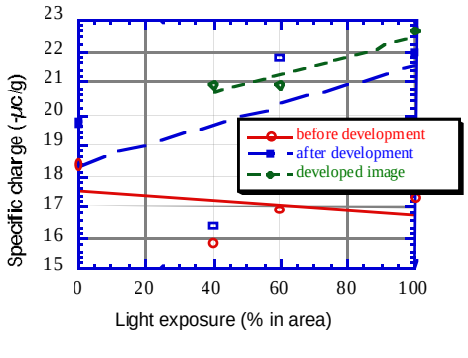

Figure 3.4. Dependency of specific charge on light exposure (d) C4

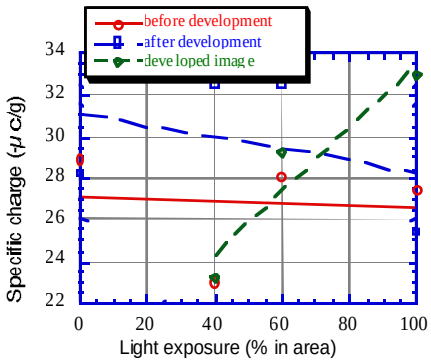

Figure 3.5. Dependency of specific charge on light exposure (e) P1

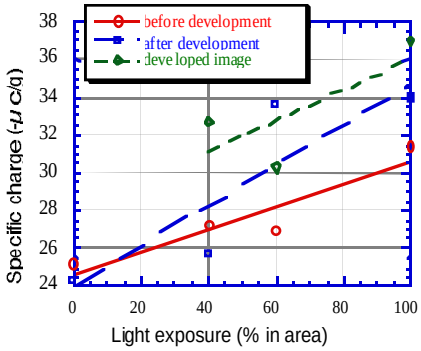

Figure 3.6. Dependency of specific charge on light exposure (f) P2

The dependences of specific toner charge on the ratio of light exposure are shown in Fig.3. Rough tendencies are shown by solid or broken lines in Fig. 3. It is considered that specific toner charge before developing zone shows no dependence on light exposure. But, it is recognized there is some dependence. This is because some toners on developing roller are charged doubly where toners remain on the developing roller, on the other supplied freshly.

It is observed, as the ratio of light exposure increases, specific toner charge on photoreceptor increases.Both toner charges show increase as the light exposure increases and the charge is bigger than the charge before developing zone. The possible mechanisms of toner charge change by passing developing zone are:

1) charging by contact with photoconductor[8],
2) charging by friction with developing roller,
3) air break down and so on.

It is recognized, the toner charge on photoconductor and after developing zone increases as the ratio of light exposure increase. The increase of exposure causes the increase of the electric field between developing roller and photoreceptor. So it is considered that the electric field affects the mechanism of toner charging mechanism.

If charge is transferred to toner from photoconductor under the electric field, toner charge will decrease, but experimental results is contrary. The possibility of air breakdown between toner and developing roller is little, because voltage at the distance is less than Paschen condition. When conductive material rubs insulator surface with voltage applied condition, it is reported that insulator surface is charged[9]. It is considered that toner is re-charged by frictional contact with developing roller under the application of electric field.

Table.1 Measured Specific Toner Charge in Developing Process

Specific toner charge(q/m) in developing process / Toner type		q/m of before developing	q/m of after developing	q/m of developed image
Crushed	C1	12.4	16.7	11.9
	C2	5.80	4.97	10.0
	C3	10.6	14.0	15.4
	C4	15.9	16.4	20.9
Polymerized	P1	23.0	32.5	23.2

Specific toner charge at the light exposure ratio 40% are summarized in Table 1. Some toner shows remarkable change in charge by passing the developing zone. These difference is thought due to the difference of contact condition of toner with developing roller at developing zone.

Conclusion

Relation of toner charging between in rotating cylinder and in real developing unit is investigated. In general, the relation shows correlation tendency. Specific charge of toner is measured at three points of developing process. It is observed that toner charge increases after passing the developing zone, where toner contact with photoconductor and friction between toner and photoconductor/developing roller arises. The reason of the increase of toner charge is considered that toner is re-charged by friction under the condition of electric field application.

These results are thought to be useful in understanding developing mechanism.

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Biography

Hiroshi Suzuki is student of Prof. Hoshino, Nippon Institute ofTechnology. He is now studying developing process.

Hoshino Yasushi is Professor of Nippon Institute of Technology. He gained Bs., Ms. and Dr. degrees from University of Tokyo, 1970, 1972, and 1984 respectively. After he gained Ms. degree, he joined Electrical Communication Laboratories of NTT and developed first LED printer, high speed laser printer, color laser printer by using ultra elliptical laser beam scanning, photo-induced tonning technology and ion flow printing. He moved to Nippon Institute of Technology on 1994. He published more than 20 papers and several papers also in IS&T's Journal. He attended almost NIP congresses.