Toner Having High Durability for Non-Magnetic Mono-Component Process

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Abstract

In a Non-magnetic Mono-component Process, High durability toner for Longer Life Cartridges is expected especially for higher printing speed. The key factor for long life is the high durability toner and it can be measured by the level of contamination onto the charging blade/developer roller. A toner was developed with this feature and the improvement carried out by utilizing a Cyclo Olefin Copolymer resin. The toner durability was examined by comparing on the charging blade/developer roller contamination with typical toner binders such as styrene/acrylic and polyester resins.

Introduction

Different types of developing systems are adopted for printers, copiers and multi function machines depending on uses.

As a recent trend, smaller size, less cost for both of the machine and the supplies and also the saving the natural resources are highly required.

It is said that the non-magnetic mono-component process is suitable than the dual component process for that purpose. However, the toner electrical charge need to be generated at the charging blade thus the stress onto the toner particle is higher. Because of this reason, the breaking of particle, the contaminations onto the charging blade/developer roller tend to occur and course the defect print quality accordingly.

Further, the higher printing speed is required recently even to the non-magnetic mono-component process therefore the stress onto the toner particle would be increased.

The important quality requirements are stability of print quality and high durability toner.

The stability of print quality means that the toner should have less change through the life. From the viewpoint of toner designing, the durability of toner particle is one of important factor. Presently, styrene acrylic and polyester resins are mainly utilized as toner binder however Cyclo Olefin Copolymer resin has being introduced as a potential binder for toner because of its eco-friendly properties. In this paper, by comparing the toners made from those three resins, high durability and fusing properties of Cyclo Olefin Copolymer resin toner is investigated.

Experimental

Toner Sample

Preparation of Toner Sample

Following materials were premixed, extruded, crushed and classified. An average particle size 9µm toner was obtained.

Binder resin: 100 parts
Carnauba Wax: 5 parts
Carbon black: 7 parts
Metal complex CCA: 1.5 parts

The thermal properties of toner samples are shown in Table 1.

Table 1. Thermal Properties

	St/Ac Toner	Pes. Toner	COC Toner
Ti ºC	108.3 (121.4)	111.3 (117.0)	106.4 (121.6)
Tm ºC	127.9 (140.4)	132.4 (142.3)	128.7 (141.5)
Tg ºC	56.2 (65.7)	62.7 (64.1)	51.4 (63.4)

Ti: Melt starting temperature
Tm: Softening point temperature
Tg: Glass transition temperature
( ): thermal properties of the resin

Durability of Toner

- **Mixing Test 1**

Post Treatment

Each toner samples were post-treated by the high-speed mixer with the following condition;

0.8 wt% of Silica A and 0.3 wt% of Silica B were mixed 3 min. with 30m/s tip speed.
Silica A: BET surface area 50 m^2/g surface treated
Silica B: BET surface area 110 m^2/g surface treated

By revolving a developing roller in the toner cartridge without consuming and replenishing the toner, streaks were observed on the developing roller. The streaks on the developing roller were caused by the contamination onto the charging blade. Therefore, it is thought that the streaks represent the durability of the toner. The developing roller diameter was 18mm and the revolution speed was set to 320rpm.

Table 2. Mixing Test 1

	St/Ac Toner	Pes. Toner	COC Toner
Before	None	None	None
1hr	Some	None	None
2hr	Many	None	None
3hr	Many	None	None

The results are shown in Table 2. The St/Ac toner showed many streaks on the developing roller after 2hours while Pes and COC toner did not show any streaks.

- **Mixing Test 2**

To prevent the toner contamination onto the charging blade, several approaches are effective, for instance, increasing the thermal properties of the binder resin, selecting the suitable post treatment additives, optimize the amount of the post treatment additives and others.

In this test, the amount of post treatment additives were decreased to half to reduce the influence of the post treatment.

The results are shown in Table 3.

Table 3. Mixing Test 2

	St/Ac Toner	Pes. Toner	COC Toner
Before	None	None	None
1hr	Many	Few	None
2hr	Many	Some	None
3hr	Many	Some	None
4hr	—	Some	None
5hr	—	Many	None
6hr	—	Many	None

With the St/Ac toner, many streaks on the developing roller were observed after 1 hour. The COC toner did not show any streaks after 6 hours while the Pes toner showed some streaks after 2 hours and then many streaks appeared after 5 hours.

Although the Pes toner sample has slightly higher thermal properties than the COC toner, the streaks or contamination level of COC toner was better. This indicates that COC toner is suitable for the non-magnetic mono-component process.

Toner Particle Size Change in Cartridge

Toner Particle size changes in the cartridge was examined to predict the toughness of each binder resin.

The toner sample was taken from the cartridge every 1 hour at the Mixing test 2. As shown in Fig.1, there were slight changes at the population 5 μm under % on the entire sample, however no distinct differences were observed between the samples. Strength of the COC toner is comparable with other samples.

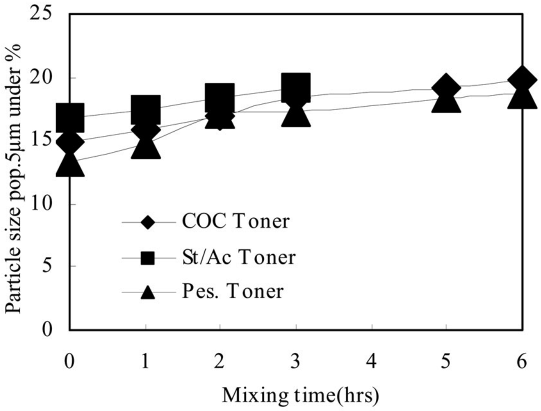

Figure 1. Particle size change pop 5μm under %

One of the features of COC toner is lower specific gravity. Following is the specific gravity of the each toner.

COC Toner: 1.0 g/cc
St/Ac Toner: 1.1 g/cc
Pes.Toner : 1.2 g/cc

The COC toner has lower specific gravity than other toners. Even though the clear differences were not observed at the above particle size change test, because of lower specific gravity of COC toner, less stress is expected during the mixing and it could be an advantage for the durability.

Electrostatic Charge

The electrostatic charge on the developing roller was also measured at the Mixing test 2. The measurement was done by the suctioning the toner on the developing roller. The results are shown in Fig. 2. The COC toner showed the highest charge, followed by the St/Ac and Pes toner.

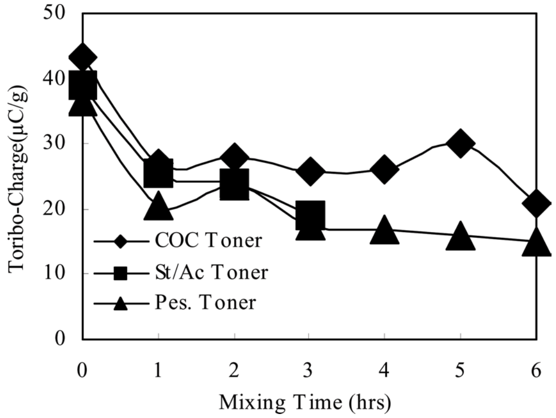

Figure 2. Electrostatic charge

Fusing Ability

A fusing ability test was performed to examine the fixing strength and the non-offset window. The sample toner was developed on the 75g/m^2 paper and fixed under the 200mm/sec process speed. Fixing strength was measured by the differences of the image density before rubbing and after. Rubbing the image was done 6 times for each test by typewriter eraser with 1kg weighting. The results are shown in Table 4.

Table 4. Fusing Ability

	Non offset Window (°C) 125 150 175 200 225 250	Remaining rate 170°C (%)
COC Toner	145 ~ 220	86.0
St/Ac Toner	150 ~ 220	80.1
Pes. Toner	145 ~ 230	84.1

The fixing strength of COC toner was almost equal or little better than Pes toner, however St/Ac toner was slightly lower. The COC toner has enough fusing ability.

Result and Discussion

As shown in Table 2 and 3 from the mixing tests, although the post treatment additives were reduced to half, no streaks=contamination onto the charging blade was observed. From the viewpoint of toner designing, less attention to the contamination onto the charging blade is needed and it is an advantage on formulating the post treatment additives. The contamination level of the COC toner was better than the Pes toner and the St/Ac toner. It is assumed that the COC resin has olefinic structure which is polymerized from ethylene and norbornen and has less oligomer at the lower molecular portion.

As shown in Fig. 1, the COC toner particle size change was slight, almost equal to other samples and the specific gravity is lower by comparison. It is inferred that the COC toner has less stress during the mixing process which leads to higher durability.

As shown in Fig. 2, the electrostatic charge of the COC toner was the highest with low specific gravity. Because of this higher electrostatic charge toner formulating becomes much easier. In case of the jumping development process, in general, higher electrostatic charge and lower specific gravity tends to give higher image density. This predicts that the COC toner is suitable for not only the non-magnetic mono-component process, but also the jumping development process. From the fusing ability data shown in Table 4, the COC toner has enough non-offset window and better fixing strength than the Pes toner. This COC toner system could be suitable for low energy fusing systems.

Conclusion

The toner made from COC resin having high durability for non-magnetic mono-component processes can be summarized as follows;

1. The COC toner has enough tolerance for the contamination onto the charging blade than typical St/Ac and Pes toners.
2. The COC toner has high electrostatic charging ability.
3. The COC toner has enough fusing ability compared with typical St/Ac and Pes toners.

Based on those investigations, it is apparent that Cyclo Olefin Copolymer resin toner has high durability for non-magnetic mono-component processes.

References

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2. Nobuyuki Aoki; IS&T NIP18 (2002)

Biography

Takayuki Hamanaka received his bachelor in Industrial Chemistry from the University of Seikei, Japan, in 1993 and then joined Research and Development section in Chemical Products Division of Tomoegawa Paper Co., Ltd. He is currently working on toner development for copiers and printers.