Environmentally Friendly Toner from Natural Materials

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Abstract

Companies developing new products are required to give consideration to its products' influence on the environment; of which the electro photographic industry is no exception. Various governments support these actions which is vital to the preservation of our global environment and human safety. The recycling ratio of copier and printer parts is rising exponentially, however the establishment of recovery or recycling systems of toner cartridges is one step towards preserving the environment. This study explores how the technology and use of natural cycle materials produce environmentally friendly toners. The results will show that this new toner can replace the CO2 producing toners.

Introduction

The world-wide production volume of toner is estimated at 150,000 tons per year. After toner has been used, most of it is incinerated or deposited into landfills. The process of burning toner produces CO2; the main source of which is the binder-resin which is made from oil-based resources. This study replaces oil-based resins with Poly Lactic Acid (PLA) a natural, plant-based resin.

PLA is synthesized carbohydrates from corn, sugarcane, or other plants. When PLA is incinerated, CO2 is released, however the CO2 is absorbed by photosynthesis of the plant. This is called "Carbon neutral." In other industries, PLA has already been used in commercial products, replacing the oil-based plastics.

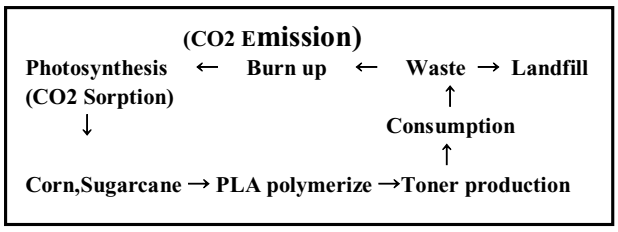

Figure 1. Environmental cycle of PLA used in toner.

Figure 1 shows the environmental cycle using PLA in toner.

This cycle is completed in less time compared to toners using oil-based resources. The PLA CO2 cycle is more acceptable environmentally.

The physical and thermal properties of PLA are similar to generic plastics, but too hard to be used as a toner binder, and must be modified. Therefore, compounding PLA with polyester resins and other natural-based materials is being researched.

Experiment

Toner Sample

The following materials were used to obtain 9 µm toner using conventional processes. Additives such as reforming agents and wax are also natural-based materials used to reduce the CO2 generation.

Table 1. Toner Formulation

Reference Toner		Pes + PLA Toner	
Polyester resin	90 parts	Polyester resin	47 parts
Wax	2 parts	PLA	32 parts
Carbon black	7 parts	Additive	10 parts
CCA	1 parts	Wax	3 parts
		Carbon black	6 parts
		CCA	2 parts

Table 2. Thermal Properties

	Reference Toner	Pes + PLA Toner
Ti ºC	106	108
Tm ºC	126	128
Tg(mid) ºC	58	58

Ti: Melt starting temperature Tm: Softening point temperature
Tg: Glass transition temperature

Electrostatic Charge

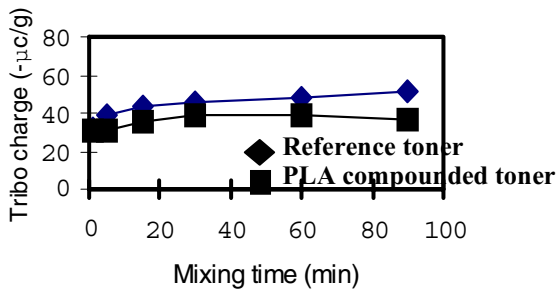

Figure 2. Electrostatic Charge by time

Figure 2 shows the electrostatic charge stability of each sample using a Silicone coated carrier. The measure-

ment was done with a Toshiba blow off charge device. The PLA compounded toner showed comparable charge stability compared to the referenced toner.

Fixing Test

The non-offset range of the PLA compounded toner was wider than the referenced toner. However, the fixing strength rate of the PLA compounded toner was slightly lower than the referenced toner shown in Fig. 3.

<Non-offset range>

Reference toner: 130 – 185 degree C
PLA compounded toner: 120 – 185 degree C

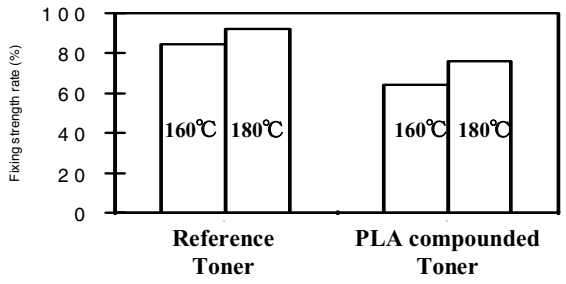

Figure 3. Fixing strength rate

Estimation

Comparison of CO2 Sources

Following are the conditions of the estimation.

1) All of the toner manufacturing processes were the same, except the resin process.
2) Disposal method of the toner is incineration.
3) All of the CO2 that was released during the burning process of the PLA toner was absorbed by photosynthesis.
4) The CO2 source from resin is counted from raw material procurement to polymerize.

Depending on the data source, estimation results may vary. Therefore two different data sources were utilized.

In addition, Case 2 shows plant-derived fuel was used to produce PLA.

Figure 4 and Fig. 5 shows that the CO2 emission amount of the PLA compounded toner was reduced compared to the referenced toner.

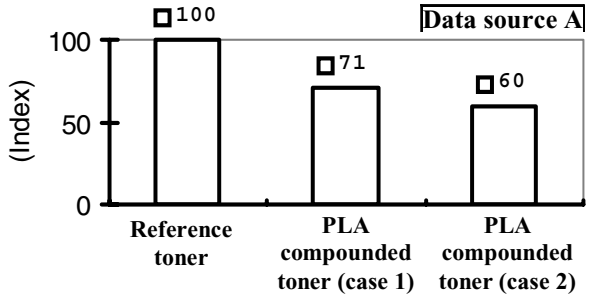

Figure 4. Emission amount of CO2 (Estimation 1)

(The emission amount of the CO2 from polyester resin is drawn from the data of amorphous PET released by Cargill Dow Co., Ltd.)

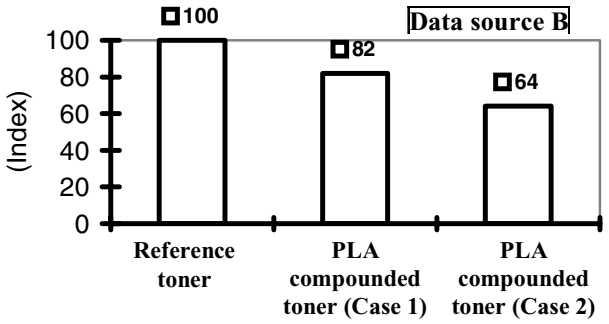

Figure 5. Emission amount of CO2 (Estimation 2)

(The emission amount of CO2 from the polyester resin is drawn from the data of polyester fabric released by LCA Japan data-base.)

In Case 1, the emission amount of CO2 can be reduced about 20~30% and, with Case 2, the emission amount of CO2 can be reduced about 40%.

Conclusion

The use of PLA compounded toners for the reduction of CO2 emission amounts can be summarized as follows:

1. Thermal properties of the PLA compounded toner are similar to the polyester resin toner.
2. The PLA compounded toner can obtain comparable electrostatic charging stability with polyester resin toner.
3. The non-offset range of PLA compounded toner is wider than the polyester resin toner. However, the fixing strength rate of the PLA has room for improvement.
4. Compounding 32% of the PLA and other natural based materials with polyester can reduce the emission amount of CO2 about 40% or more.

Based on the study, even though improvement in the thermal properties is needed, PLA has the potential to reduce the amount of CO2 released into the environment.

References

1. Nobuyuki Kawashima Chemical Economy No.8 P55 (2002)
2. Yoshiharu Toi Illume Vol.13 No.2 P4～21 (2001)
3. LCA Japan forum LCA data-base

Biography

Yoshihito Suwa received his Bachelor's Degree in Hygieiology from the University of Kitasato, Japan, in 1991. He then joined the Research and Development Department in the Chemical Products Unit of the Imaging Material Division of Tomoegawa Paper Co., Ltd. He is currently working on toner development for copiers and printers.