Influence of Aperture Electrodes Thickness on Toner Cloud Beam Control Characteristics

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Abstract

Controlling toner cloud by electrostatic force is a novel printing method. It has possibilities of advantages such as simple and compact printing mechanism. In order to obtain the range of printing speed, a detailed investigation and analysis of dot formation condition is necessary. In this research, the dot formation by pulsed control of toner passing condition is carried out and dot formation characteristics is obtained in the pulse duration of 10^{-4}*s-*10^{-3}*s.*

Introduction

The printing method of TCB (Toner Cloud Beam) has been studied. It has possibilities of simplicity of design and small printer. The control of conductive toner motion is important in TCB printing. The TCB research is under way[1-6], but solving the optimization of the dot formation conditions remains as a major task. The optimization of the dot formation conditions is influenced by many factors such as the distance between the electrodes, the thickness of electrode, the applied voltage and so on. In this study, the dot formation characteristics dependence on the thickness of the aperture control electrodes have been investigated, and the relationship between the pulse duration (10^{-4}s~10^{-3}s) and dot size is examined. These data are important as basic data for realizing the device of TCB printing.

Experimental

To control toner cloud by a pair of aperture electrode adequately is important in TCB, which is a novel printing technology with characteristics of simple mechanism. Schematic diagram of TCB experiment is showed in Figure 1. Experimental toner control mechanism of 4 electrodes of upper electrode, a pair of aperture electrode and lower electrode is composed, and voltages are applied to each electrode. Two modes of toner passing through aperture electrode are showed in Figure 2. It is OFF state when toner is can not pass, while it is ON state when toner can pass.

The two SEM micrographs of toner are showed in Figure 3 which enlarged 5000 times and 1000 times respectively. For developing materials, the conductive toner is very important to TCB, physical property parameter of toner is showed in Table 1.

Electric field analysis is carried out by ELFIN (ELF Corporation: www.elf.co.jp). The dot size dependence on aperture electrode thickness is investigated experimentally. When the GC voltage is -20V, toner can not pass the aperture electrodes. The GC voltage is controlled between -20V and +250V. Dot formation by pulsed control of toner passing condition is carried out.

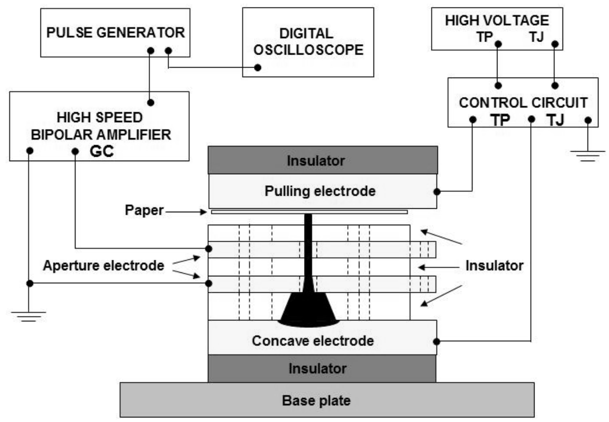


Figure 1. *The experimental system of TCB.*

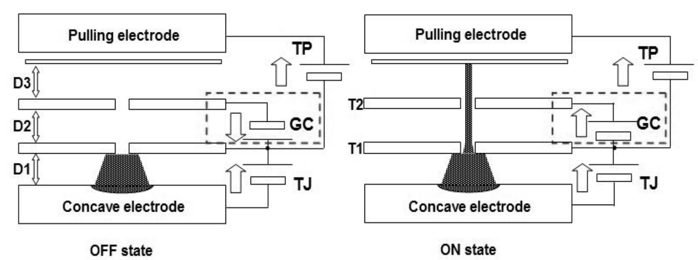


Figure 2. *States of the electric field of the aperture control electrode, a) OFF state; b) ON state.*

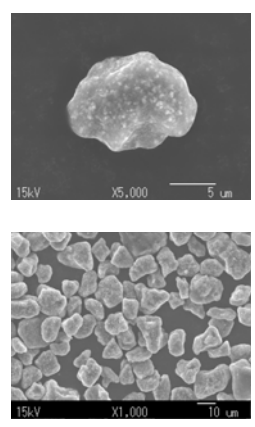


Figure 3. *The SEM micrographs of Toner.*

Table 1. *Physical property of toner.*

Physical property	
Diameter (Average)	8~11μm
Specific gravity	0.75g/cm^3
Resistance	1.5×10^8 Ω/cm

Table 2. *Experimental conditions.*

Variable	Value
TP	750 V
GC	-20 V~250 V
TJ	-550 V
Ø	0.5 mm
D1,D2,D3	0.5 mm

The experimental conditions are shown in Table 2. The diameter of aperture is Ø, and the distances between the aperture electrodes are D1, D2, and D3.

Results and Discussions

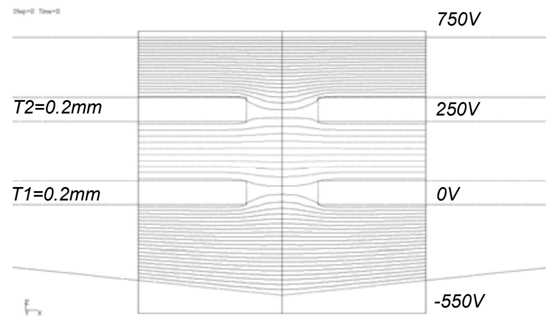
Figure 4 shows the equipotential lines around the aperture control electrode. The (a) and (b) is ON state when T is different thickness, in the ON state, the toner is allowed to pass through the aperture electrode.

Figure 5 shows the toner trajectory in the aperture electrode. Figure 5 shows that the amount of passing toner will be less by use of the thicker aperture electrode. These results of simulation agree with the experimental result.

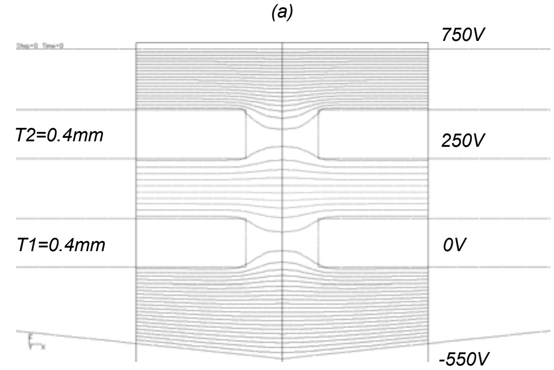
Figure 6 shows the dot images that are obtained by this experiment. When pulse duration is 10^{-4}s, the dot size is 0.019mm^2. When pulse duration is 10^{-3}s, the dot size is 0.15mm^2. In the same thickness of aperture electrode condition, if the pulse duration becomes shorter, the dot size is smaller. Namely, the amount of passing toner is becoming lesser. According to the result of dot image, there has enough amount of passing toner to make the dot which the pulse duration just more than 10^{-4}s.

From the former research[7-8], it is known that the thickness of electrode has big effect to toner control characteristics. Figure 7 shows the dot sizes dependence on pulse duration under different T1 condition. From the Figure 7, thickness of T1 is changed to 0.3mm and 0.5mm when T2=0.4mm is in the pulse duration condition. From Fig.7, it is found that dot size is smaller when the thickness of lower aperture electrode increases. It is considered that the increase of the electrode thickness narrow the toner trajectory of passing through the aperture electrode.

From Figure 8, it is found that the dot size tendency shows also same behavior when the thickness of upper aperture electrode increase.

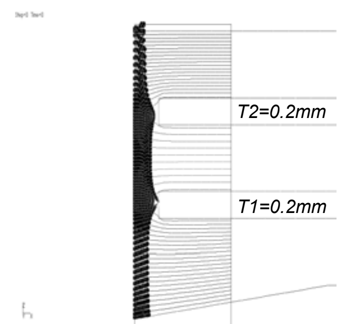


(a)

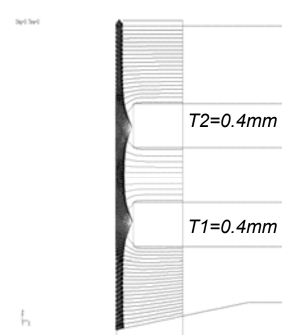


(b)

Figure 4. *Equipotential lines around the aperture control electrodes, a) ON state when T=0.2mm; b) ON state when T=0.4mm.*

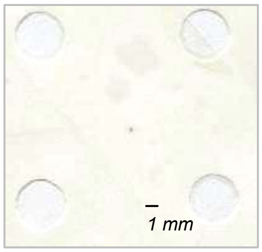


(a)

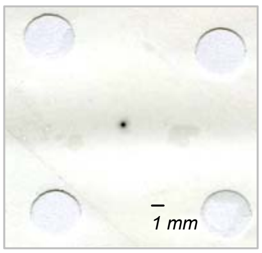


(b)

Figure 5. *Toner trajectory around aperture electrodes, a) T=0.2mm; b) T=0.4mm.*



T1=T2= 0.2(mm), t= 0.0001(s)



T1=T2= 0.2(mm), t= 0.001(s)

Figure 6. *The sample of dot under different pulse duration.*

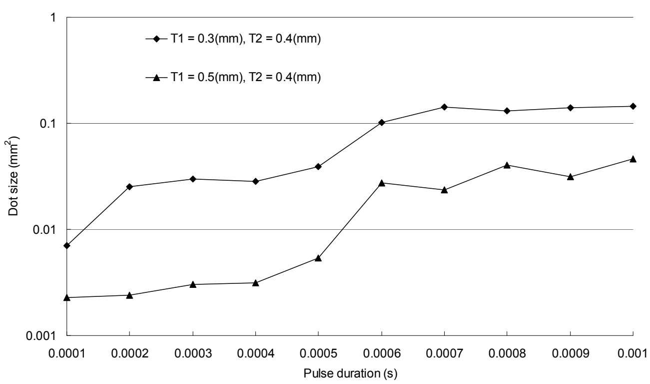


Figure 7. *Dot sizes dependence on pulse duration under different T1 conditions when T2= 0.4 mm.*

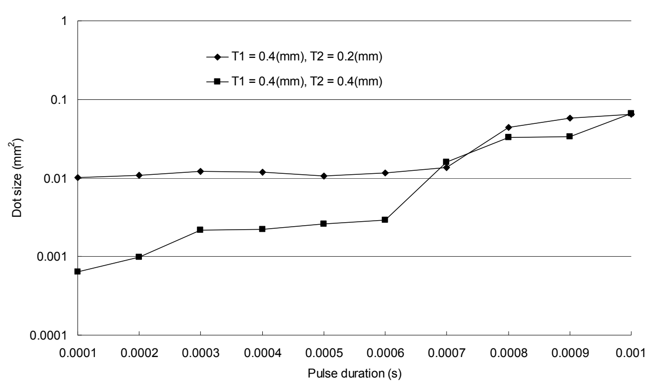


Figure 8. *Dot sizes dependence on pulse duration under different T2 conditions when T1= 0.4 mm.*

Conclusions

The aim of this study is to understand the effect of the thickness of aperture electrodes and pulse duration on dot formation. The thickness of the electrodes is changed from 0.2mm to 0.5mm and the pulse duration is controlled 10^{-4}s to 10^{-3}s. It is obtained when thicken the lower side aperture electrode, the amount of passing toner decreases and dot size becomes small. When thicken the upper side aperture electrode, concentration of toner to the center and smaller dot size is obtained.

Acknowledgements

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