

Dot Formation by Toner Beam from Toner Cloud

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Abstract

In non-impact printing technologies, printing methods using toner are very important. In a sense, toner printings such as electrophotography, toner jet, ion projection and magnetography are technologies how to control toner to paper precisely.

A new method "TCB (Toner Cloud Beam)" is proposed. The methods of toner cloud generation and confinement of its toner cloud between electrodes by applying voltage are already proposed. By applying extracting electric field to the toner cloud, toner beam is extracted from the toner cloud and the toner beam is projected to paper. It is confirmed that dot is formed on paper by this method.

1. Introduction

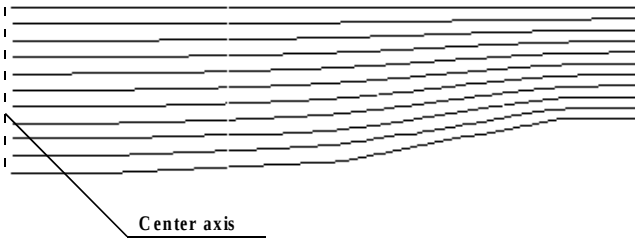
In non-impact printing process, control of toning material is important point. Main evaluation items of the printing process are: print quality, printing speed and simplicity of printing mechanism. The print quality is controlled by the precision of position where toning material is attached to a paper and the controllability of amount of attaching toning material.

Although the printing mechanism of electrophotography is relatively complex, its print quality and its speed are excellent. So, the electrophotography is widely used as one of major non-impact printing technologies.[1] Efforts to realize new printing mechanism has been made, TonerJet® is one of important attempt. Toner is selectively conveyed to paper.[2-4] The printing mechanism is simplified compared with the electrophotography.

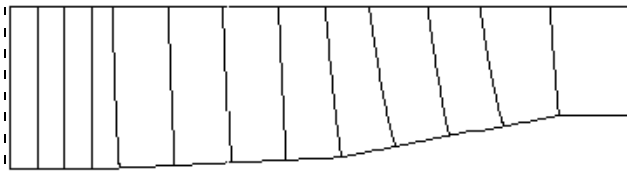
It is meaningful to make efforts for realizing new printing technologies, which have characteristics of simpler printing mechanism, higher printing quality, higher printing speed, and/or better stability and maintainability.[2-5] We propose new dot formation method "Toner Cloud Beam (TCB)" which method is that toner beam is extracted from toner cloud generated by electric field applied between electrodes and the toner beam is projected to paper. In this report, the dot formation mechanism and experimental results are explained.

2. Dot Formation Mechanism

When more than certain voltage is applied between electrodes, conductive toners move up and down between the electrodes.[6,7] This is because the toners are charged by conduction from the electrode under the electric field applied and electric force (toner charge x electric field) works on the toners. The conductive toners can be confined between electrodes using dented electrode.[8] This confinement is realized by electric field toward central axis of the dent of the electrode. Figure 1 shows an example of the electric field analysis. We can see the equal potential lines are deformed at the slope area of the dent and the electric force lines are also declined there. When the toner moves upward, the force toward the central axis worked on toner more effective than when toner moves downward. This difference of the effectiveness of the force is considered due to the difference of toner speed.



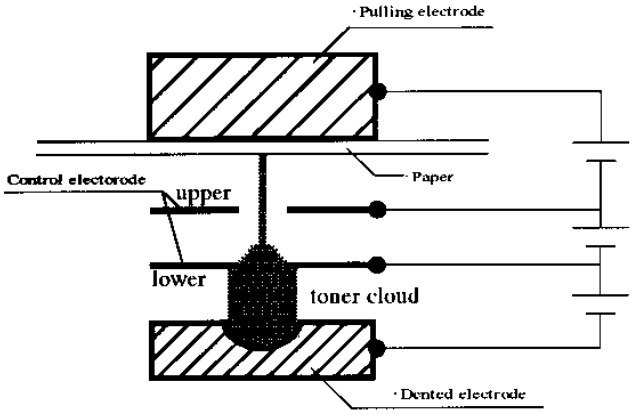
(a) Equal-potential line



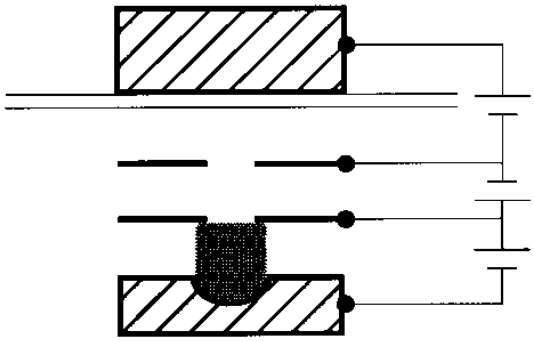
(b) Electric force line

Figure 1. Results of electric field analysis.

The generation of toner beam is controlled as shown in Fig. 2. Figure 2 (a) shows toner beam "on" state and Fig. 2 (b) shows toner beam "off" state. From the dented electrode, negatively charged toner moves upward. When higher voltage is applied to the upper control electrode than the lower control electrode, the toner moving upward can pass through the control electrode. But, when the voltage of upper electrode is less than the lower electrode, the toner can not pass the control electrode. Because the direction of electric field in the aperture of control electrode become blocking.



(a) "on" state



(b) "off" state

Figure 2. Toner beam control mechanism.

3. Experimental

To confirm the generation of toner beam, experiments are carried out on 1 dot with enlarged model, as the first step. Experimental conditions are as follows; toner: conductive and its size 7-12micron meter, control electrode: diameter of aperture 0.5mm and thickness of insulator 0.5mm, dented electrode: diameter of dented area 10mm and its depth 0.2mm.

Potentials applied to electrodes as follows: pulling electrode +300 - +400V, upper control electrode -100 - +100V "on state" and -300 - -150V "off state", lower control electrode 0V and dented electrode -300 - -500V.

Experimental procedure is as follows: Toner of weight 1mg is supplied to the dented area of the electrode. Paper is set on the pulling electrode. Then the voltages are applied to each electrodes. Time duration of voltage application is 1 second. Toner dot formed on paper is fixed by transparent adhesive tape.

4. Results and Discussions

Figure 3 shows the toner dots obtained on various potential conditions of upper control electrode. When the voltage applied to the upper electrode increases, it is found that the dot size increases. The relation is shown in Fig. 4. According to the decrease of the voltage of the upper electrode, dot size decreases. The dot size is controlled by amount of toner passing through the aperture of the control electrode. When the voltage of upper control electrode increased, the toner passing area of aperture cross section increases. So, toner amount increases as the voltage increases. The reason that toner passes through the aperture when the potential of upper electrode is negative, is considered as follows: the electric field within the aperture is influenced by the electric field between the pulling electrode and the upper control electrode, and also the electric field between the dented electrode and the lower control electrode.

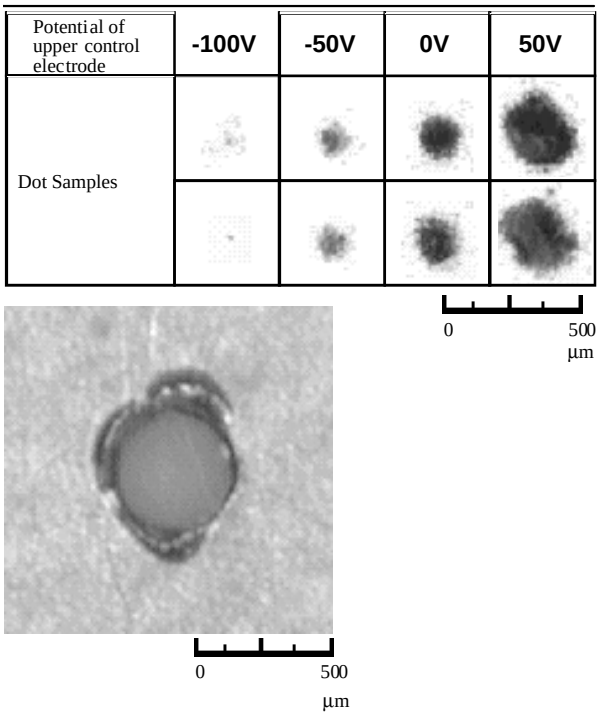


Figure 3. Toner dot of various potential conditions and aperture of control electrode. (Potential of lower control electrode is 0V)

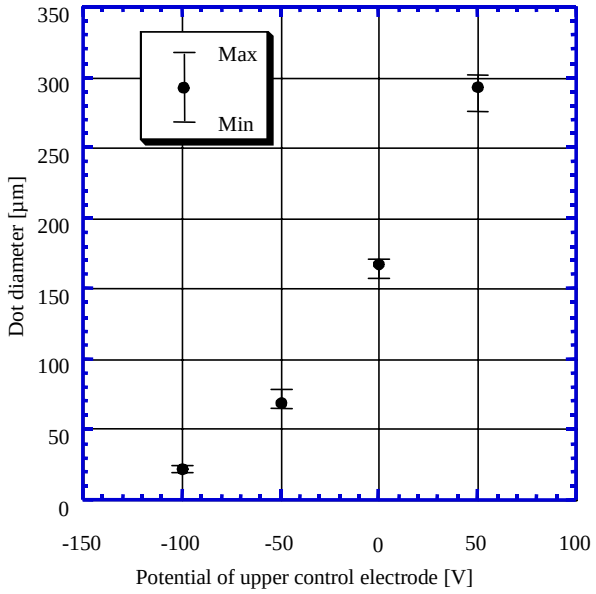


Figure 4. Dot size versus control voltage

5. Conclusion

In the non impact printing technologies, the control of toning material is the most important point. About the printing mechanism, simple mechanism is expected. In this report, new dot formation method "TCB (toner cloud beam), which has a possibility of simplifying the printing mechanism, is proposed. It is confirmed that toner cloud is generated and dot is formed on paper by electrically extracted from the cloud.

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Biography

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 (process speed 89 cm/s), color laser printer by using ultra elliptical laser beam scanning, photo-induced tonning technology and ion flow printing.

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