An Improved Technique for the Driven Characteristics for Toner Transportation

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Abstract

In this paper, we show a new type of the experimental system for toner transportation. We have obtained the following major results:

1. Employing the technique of vibrating the sheet of the printed periodic array-conductors driven by four phase rectangular pulses for toner transportation, which is assembled on the disk of piezoelectric ceramics, we have succeeded in decreasing greatly the amplitude of four phase rectangular pulses.
2. We have obtained that the toner particles adhered on the sheet of periodic array-conductors due to the adhesive force can be easily moved by vibration.

Introduction

We have already presented a technique for the toner transportation that the electrically charged toner particles can be easily transported by means of traveling wave which is generated on the sheet of periodical-array-conductors installed on the ultrasonic vibrator.[1-4]

A small disk of the ceramic vibrator is used in order to decrease the adhesive-force which acts to the toner particles on the sheet of periodical-array-conductors for improving the drive-characteristics for the toner transportation.

As a result, it is confirmed that the use of the vibration technique can obtain the good effect for toner transportation.

Experimental System of Toner Transportation

Figure 1 shows the schematic diagram of the experimental system for transporting negatively charged toner particles. This system consists of the four-phase rectangular pulse generator, the sheet of periodical-array-conductors for toner-transportation, the ceramic vibrator for vibrating the sheet vertically, the sinusoidal wave generator for supplying the electrical stimulation to the ceramic vibrator and the CCD camera system for observing the movement of toner particles.

Figure 2 shows the structure of the sheet of periodical-array-conductors for the transportation of toner particles.

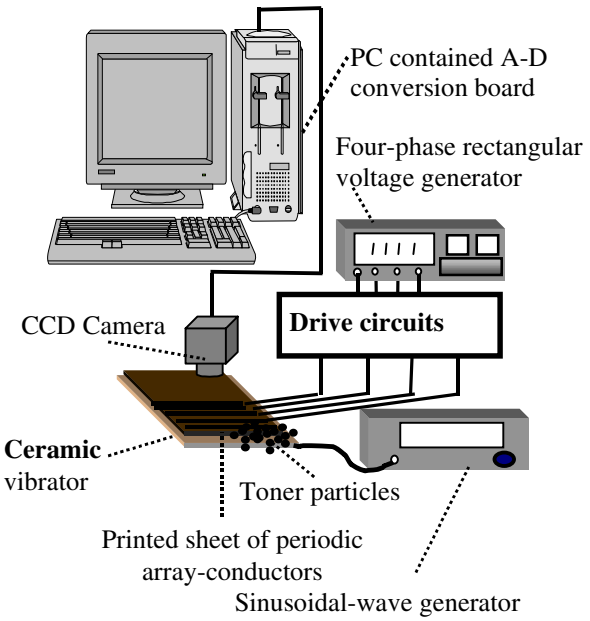

Figure 1. Schematic diagram of the experimental toner transportation system

The periodical-array-conductors are connected to the four-phase rectangular pulse generator. In the start of operation, charged toner particles are put on the sheet of periodical-array-conductors on the left side in this figure. Next, the sheet of these conductors driven by the four-phase rectangular pulses is swung to the vertical direction by the ceramic vibrator driven by the sinusoidal wave generator.

Consequently, the toner particles are floated over the sheet of printed conductors, and the adhesive force acting between toner particles and the sheet is greatly decreased.

As a result, the toner particles can be easily transported toward the direction of other end of the sheet with the low level amplitude of the four–phase rectangular pulses.

The movement of the toner particles can be observed by the monitor of the CCD camera assembled above the sheet which is used for toner transportation.

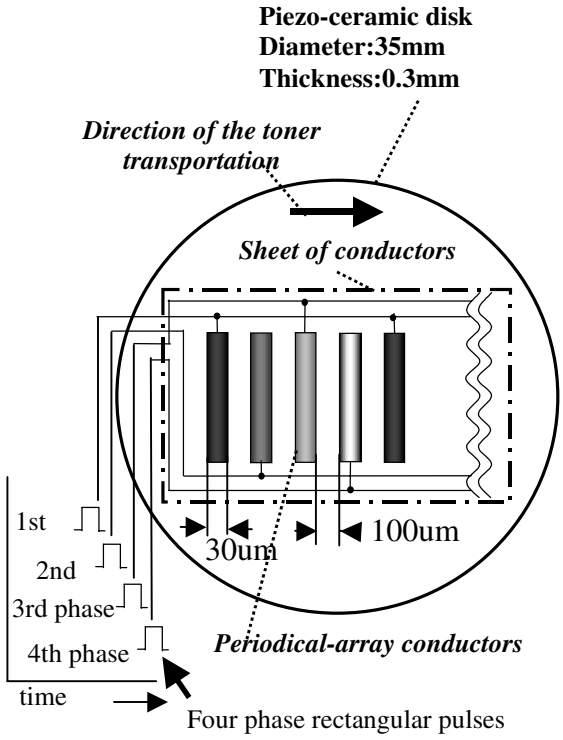

Figure 2. Outline of the sheet of periodical-array-conductors driven by the four–phase rectangular pulses

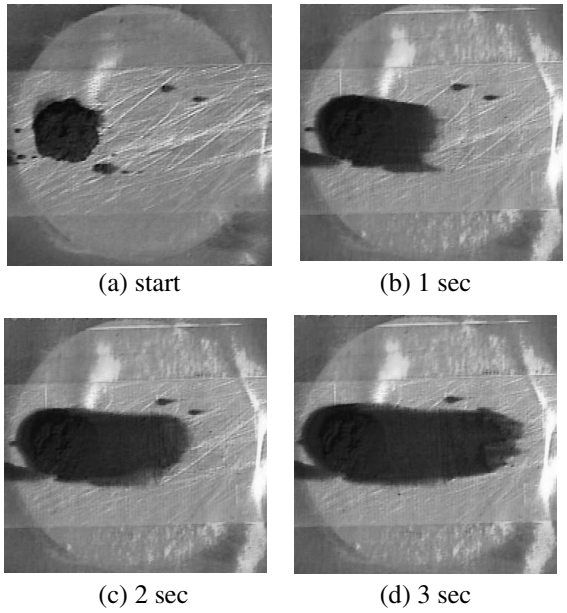

Figure 3. Photographs of the movement of toner particles observed at different duration times

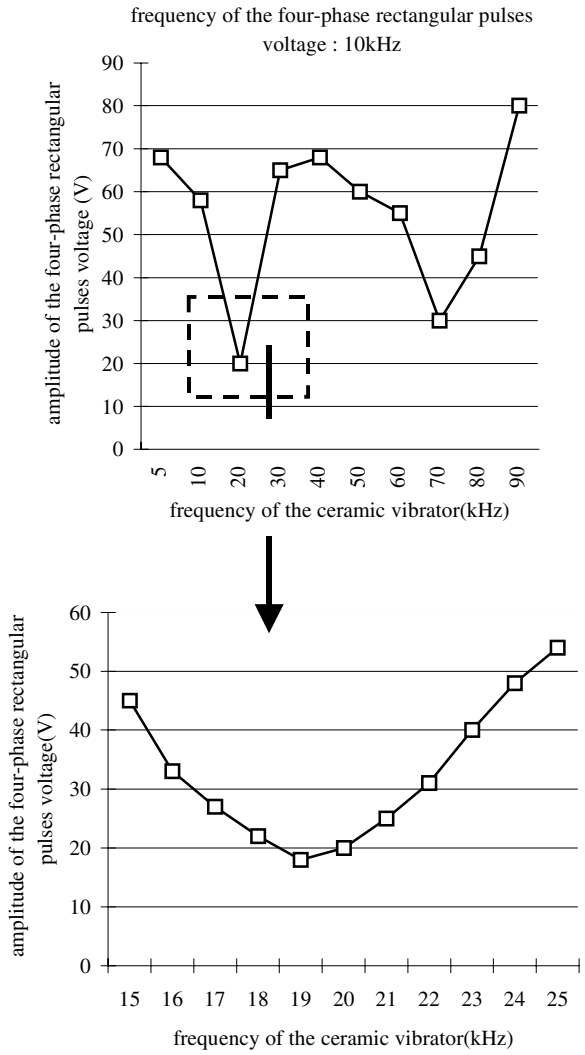

Figure 4. Relationship between frequency of the ceramic vibrator and amplitude of the four–phase rectangular pulses.

Experimental Results

Four kinds of the toner particles are used in this experiment.

Figures 3 shows a photograph of the movement of toner particles observed at different times at a position of the periodical-array-conductors.

As the characteristics for toner transportation, figures 4, 5 and 6 show the relationship between frequency of the ceramic vibrator driven by the sinusoidal wave generator and amplitude of the four–phase rectangular pulses, the relationship between frequency of the four–phase rectangular pulses and amplitude of the four–phase rectangular pulses, and the relationship between q/m of toner particles and amplitude of the four–phase rectangular pulses, respectively.

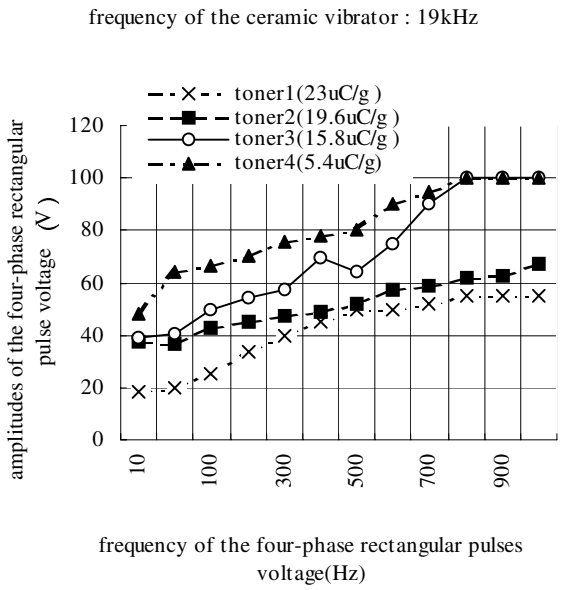

Figure 5. Relationship between frequency of the four–phase rectangular pulses and amplitude of the four–phase rectangular pulses.

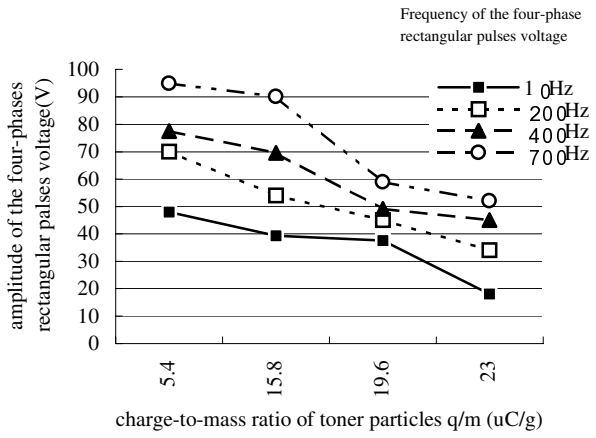

Figure 6. Relationship between q/m of toner particles (Average values) and amplitude of the four–phase rectangular pulses.

From the results of this experiment, the best operational conditions obtained are as follows:

(1) Minimum amplitude of the four–phase rectangular pulses is about 18 volt and in this situation, the frequency of the ceramic vibrator is about 19kHz. There is an optimal value between them.
(2) Minimum amplitude of the four–phase rectangular pulses depends upon q/m of toner particles.
(3) Frequency of the four–phase rectangular pulses has to be selected at low repetition rate.

Conclusion

For toner transportation, amplitude of four phase rectangular pulses can be greatly decreased by employing the technique of vibrating the sheet of the printed periodic array-conductors driven by four phase rectangular pulses, which are assembled on the disk of piezoelectric ceramics.

Acknowledgement

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