CHAPTER 3

EXPERIMENTAL

3.1 Materials

- Conducting toner (made in Japan)

  - Mean particle size: 11.25 μm

  - Resistivity: 1.55×10^{10} Ω-cm

  - The specific gravity: 1.9 g/cm^3

- Electronic paper: EP-370, 914 mm×150 m (made in Japan)

- Transparent adhesive tape

- Pulling electrode: one brass plates 100 mm×100 mm×1 mm

- Dented electrode:

  - One stainless steel 100 mm×100 mm×1 mm

  - Dented area: cone shape with 10 mm in diameter and 0.2 mm in depth.

- Control electrodes: Phenol Paper (insulating layer coated on the upper and lower surface with copper) 200 mm×150 mm×1.6 mm (manufactured by Sunhayato coporation, Minami-Ootsuka, Toshima-ku, Tokyo, Japan)

- Teflon sheet: 0.5 mm in depth (made in Japan)

- Circuit board: SRH-21B (manufactured by Sunhayato coporation, Minami-Ootsuka, Thoshima-ku, Tokyo, Japan)
- - Jump wire: 50 mm and 200 mm
- Soldering iron and solder
- Resistors

3.2 Apparatus

- Toner Cloud Beam unit (home made) comprising two important equipment:

  - Electrode: dented electrode, upper control electrode; lower control electrode and pulling electrode

  -Switching power supply for power source: VTC15SA

  (manufactured by ETA ELECTRIC IND, CO., LTD., Honhaneda, Onta-ku, Tokyo, Japan)

  -DC High Voltage Source: UHV 2KP/24 (made in Japan)

- Toner Cloud Beam unit (made in Japan) consist of this following:

  - Electrode: dented electrode, control electrodes (made in Japan), and pulling electrode

  - Four DC-DC converters: SHV12-0.5K6000P, SHV12-0.5K6000N, SHV12-1.0K2000N, SHV12-2.0K1000P (manufactured by Bellnix Co., LTD, Negishi Saitama-shi, Saitama, Japan)

- Four Power supplies: PA250-0.25A/AL (manufactured by KENWOOD IMT Corporation, Hakusan, Midori-ku, Yokohama, Japan)

- An innovative analytical balance for weighing performance: AX205, METTLER TOLEDO
- Meter Sunwa YX-360TRD for voltage measurement
- Electrometer: KEITHLEY 617 Programmable Electrometer for current measurement
- Image analysis for toner dot size analyzing: Program Image-Pro

  - Image-Pro PLUS (The Proven Solution) version 4.0.0.11 for windows 95/NT/98 number 41N41000-26111 copyright 1993-1998 Media Cybernetics, LP
- Scanning Electron Microscope (SEM): JSM-5410LV

  (manufactured by JEOL Co., Ltd, Akishima, Japan)
- ELFIN software for electric field calculation: (manufactured by ELF cooperation, Miyahara, Yodogawa-ku Osaka, Japan)

  - ELFIN (mini) version 5.02
  - ELF/Bench version 2.01
  - ELF/BEAM (mini) version 2.26
  - ELF/MESH version 3.33
  - Wmap version 1.8.3.0
- Personal Computer: Pentium 4, 2.53 GHz

3.3 Procedure

3.3.1 Experimental setup

Firstly, Toner Cloud Beam unit was prepared. Figure 3-1 shows the basic circuit for the TCB unit. The circuit requires a dc voltage source that generates high output voltage for applying to each electrode. Because the voltage drops across a resistance, which is equal to the product of the resistance and the current flowing in the resistance, so a series of resistors is used for adjusting the voltage applying to the control electrodes.

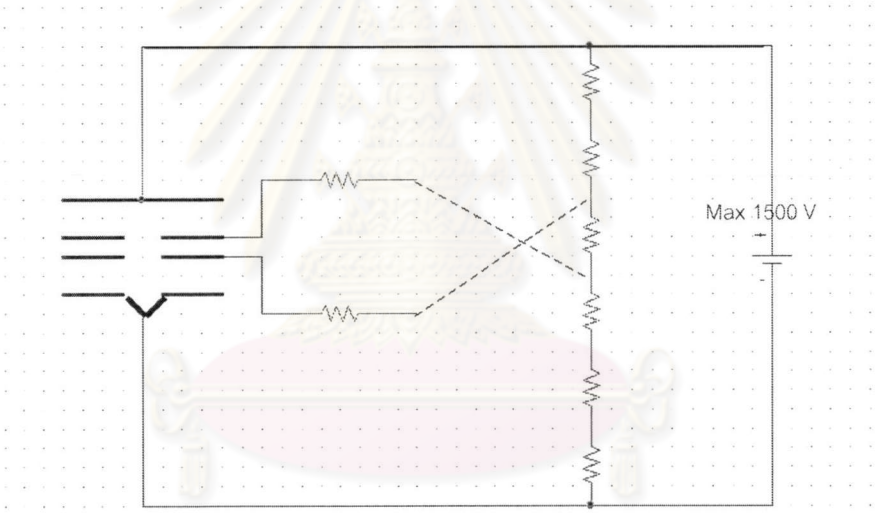


Figure 3-1 Schematic diagram of TCB unit

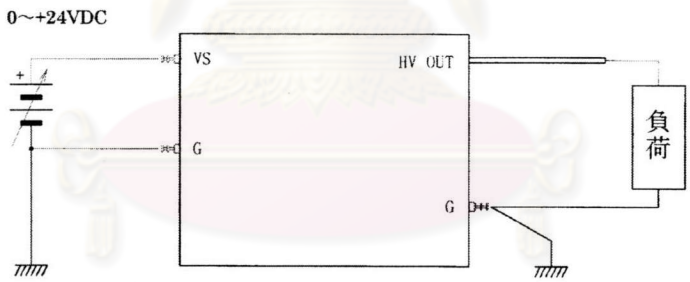
The symbol of cell in Figure 3-1 refers to a source of DC electrical power, which provides the high voltage for applying to the circuit. In the experimental setup, the DC voltage source consists of an AC-DC switching power supply and a HIGH-VOLTAGE DC power supply. Because the voltage drops across a resistance, which is equal to the product of the resistance and the current flowing in the resistance, so a series of resistors is connected for adjusting the voltage between each electrode.

The AC-DC power switching supply of VTC15SA manufactured by ETA Electronic is shown in Figure 3-2. The VTC15SA is utilized to convert the AC current into DC and supplies the DC voltage to the HV DC power supply. The input range of this switching power supply is 85 ~ 132 VAC while the output voltage is rated at 15 VDC maximum.

Figure 3-2 AC/DC switching power supply, VTC15SA

In order to generate high voltage, the HIGH-VOLTAGE DC power supply, UHV-2KP/24 as shown in Figure 3-3 (a) is used. The input/output of the UHV-2KP/24 is a non-isolated type as shown in Figure 3-3 (b).

(a)



(b)

Figure 3-3 HIGH-VOLTAGE DC power supply, UHV 2KP/24

The output voltage of the UHV-2KP/24 power supply is directly proportional to the input voltage as shown in Figure 3-4. The power supply will start with an input

voltage as low as 2 volts and will not be damaged by the input voltage as high as 24 volts. The output range of this power supply is 0 ~ 2kV.

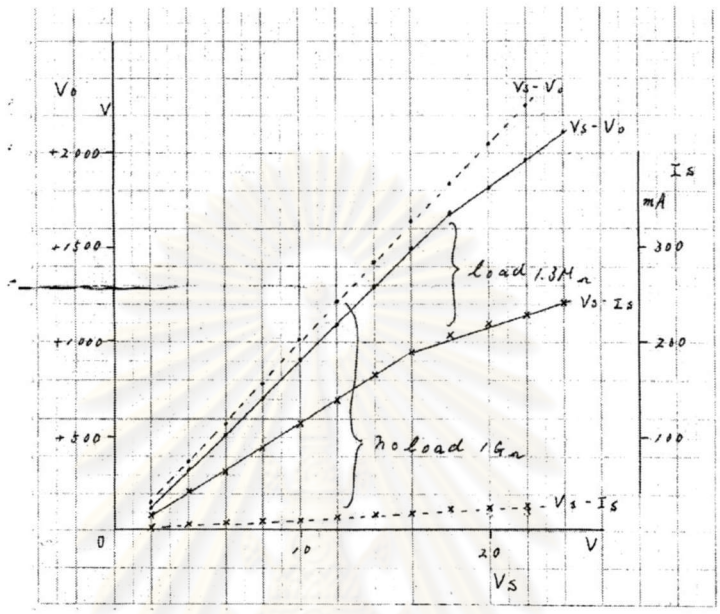
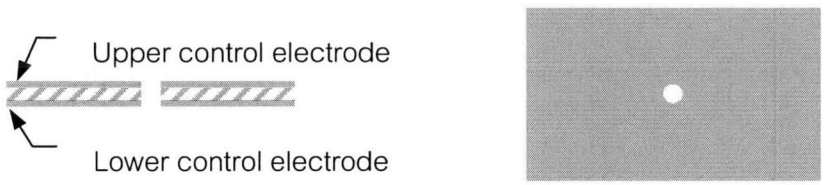


Figure 3-4 Output voltage characteristic of the DC HV power supply, UHV 2KP/24

In the TCB unit, the set of electrodes was prepared as follows. The dented electrode is a stainless steel plate, which dented to a cone shape at the center of the plate. The cone shape is 0.2 mm in depth and is about 100 mm in diameter. The phenol paper, which is an insulating layer coated on the upper and lower surfaces with copper as described in Figure 3-5 (a), is defined as the upper and lower control electrode. The phenol paper was cut into a size of about 8×10 cm and a hole was made at the center as shown in Figure 3-5 (b). The aperture of control electrode is of two different sizes, 1 and 2 mm in diameter. The pulling electrode is a flat brass plate. The stainless steel plate, phenol paper and brass plate are placed parallelly by in the horizontal line, respectively, leaving a certain distance between them using teflon sheets as spacer between them as shown in Figure 3-6. The aperture of control electrodes is set at the center of the dented area of dented electrode every time for the experiments. The TCB unit is shown in Figure 3-7.



(a) Side view (b) Top view

Figure 3-5 Control electrodes

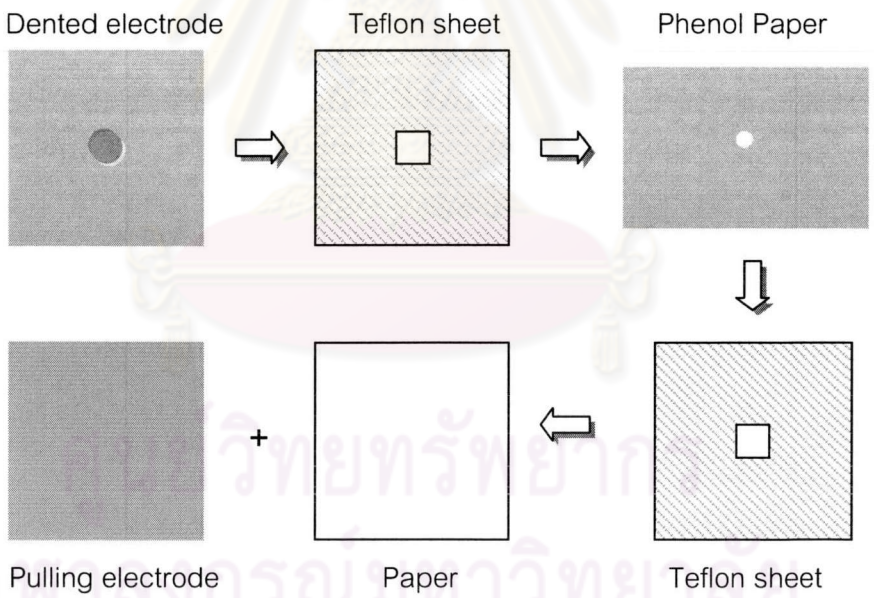


Figure 3-6 Electrodes setup in the TCB unit

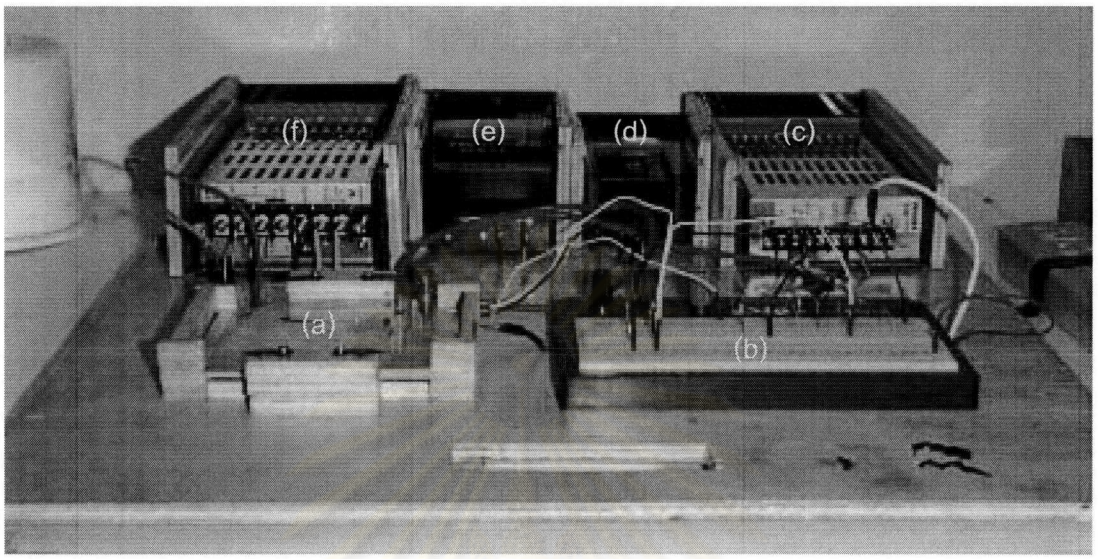


Figure 3-7 Toner Cloud Beam Unit

(a) electrode setup in TCB

(b) a series of resisters

(c) AC/DC switching power supply, VTC15SA

(d) HIGH-VOLTAGE DC power supply, UHV 2KP/24

(e) AC/DC switching power supply, VTD24SA (not in use)

(f) HIGH-VOLTAGE DC power supply, DP-0.3K1PS/24 (not in use)

3.3.2 Experimental Procedure

3.3.2.1 Electronic paper was cut in size of 100 mm×100 mm and was set beneath the pulling electrode.

3.3.2.2 Conductive toner weighed about 1 mg was applied to the dented electrode at the center of the cone shape.

3.3.2.3 The teflon sheet, control electrodes, teflon sheet and pulling electrode were placed on the top of the dented electrode, respectively. In this step, it is important to make sure that the position of dented electrode and control electrodes were properly fixed in order to the aperture of control electrodes were exactly in the center of cone shape.

3.3.2.4 The voltage was applied to each electrode. The time duration of voltage application was about 1 second. A toner dot was formed in this step and it was fixed on paper by transparent adhesive tape.

3.3.2.5 In order to elucidate the effect of applied voltage on toner dot size, the voltage between each electrode was adjusted and steps 3.3.2.1 to 3.3.3.4 were repeated. In addition, the experimental setup in Appendix A was used when the several applied voltages were performed.

3.3.2.6 In order to elucidate the effect of the aperture of control electrodes on toner dot size, the control electrodes were replaced with another control electrode that has different aperture size and the steps 3.3.2.1 to 3.3.3.4 were repeated.

3.3.2.7 The sizes of the toner dots that obtained from the experiment were investigated by an Image Analysis. The results were plotted and were analyzed by mathematics.

3.3.3 Charge evaluation

The toner jumping experiment is setup, which has the configuration as shown in Figure 2-4, and then the conducting toner is applied to the lower electrode. After that the voltage is applied. The current is measured and record according to the applied

voltage. Finally, the threshold voltage from which toners start to jump is determined and the charge of conducting toner can be evaluated.[10]

3.3.4 Determination of toner particle morphology

The high conductive toners were analyzed for the morphology in terms of particle shape and size by SEM technique

3.3.5 Electric field analysis

ELFIN software was used for simulating a system of TCB unit. The program is for evaluating the electric field and potential. We developed a working program with the given potential corresponding to the applied voltage to each electrode. The electric field data was used for simulating the toner trajectory.