Chapter 2

Experiment

2-1 Mixing Process of Paste

The various pastes mixtures, solvent, metal powder and Metallo-organic were mixed by high speed mixer (Thinky Mixer, Japan) for 3 min and then de-bubbled for 1min. The high speed mixer structures were shown at **Figure 2-1**. Subsequently, uniform pastes were formed through a triple roller grinding (EXERT, Germany), which causes breaking down of the pigment agglomerates. The triple roller grinding structures were shown at **Figure 2-2**.

2-2 Printing Process of Sample

The paste were screen-printed on alumina substrate as spiral lines and then thermally treated at a range of temperatures, according to the results of thermal study described above. The chart of screen-printing was shown at **Figure 2-3**. The dimension of screen-printed spiral silver metal lines are specifically controlled at the length of 216 cm, the line wide of 0.8mm and the line thickness of 20~40μm to promote the accuracy of the electrical measurement. The spiral line structure and printing results photo was shown at **Figure 2-4** and **Figure 2-5**.

2-3 Electrical Measurement

Keithely 2400 multimeter with a four-point probe was used to measure the bulk resistance of curing silver paste. The resistivity of the silver conducting line curied at the different temperature was calculated using the relationship of：

$$\rho = (R \cdot w \cdot d) / l \ . \qquad 2.1$$

R is the silver conducting line bulk resistance measured

w, *l*, *d* are the width, length and thickness of the silver conducting line

2-4 Thermal Analyses

The TG trace were derivatively calculated to identify the thermal decompose temperatures at which the mass loss of the paste is at a maximum. In this research, Termo-gravimetry analyzer (TGA) from Perkin-Elmer was used. Also, the TGA were performed at different heating rates including 2°C /min, 5°C /min, 10°C /min, 20°C /min and 40°C /min, in order to evaluate the activation energy. The decomposition activation energy E_a was calculated using the following formula form Doyle-Ozawa [1]:

$$-\log\phi - 0.4567\left(\frac{E_a}{RT_m}\right) = \text{constant} \qquad 2.2$$

ϕ is the heating rates (dt/dT) of the measurement and T_m is the thermal decompose temperature of the paste measured.

On-line TGA-MS measurements were performed simultaneously using the STA-409CD with Skimmer coupling from Netzsch, which is equipped with a

quadrupole mass spectrometer QMA-400 (max. 512 amu) for Balzer. For TGA-MS measurements, a heating rate of 10℃/min and a gas was He and dry Air.

Reference

1. C. D. Doyle, “Kinetic Analysis of Thermogravimetric Data,” J. Appl. Polym. Sci., 285 (1961).

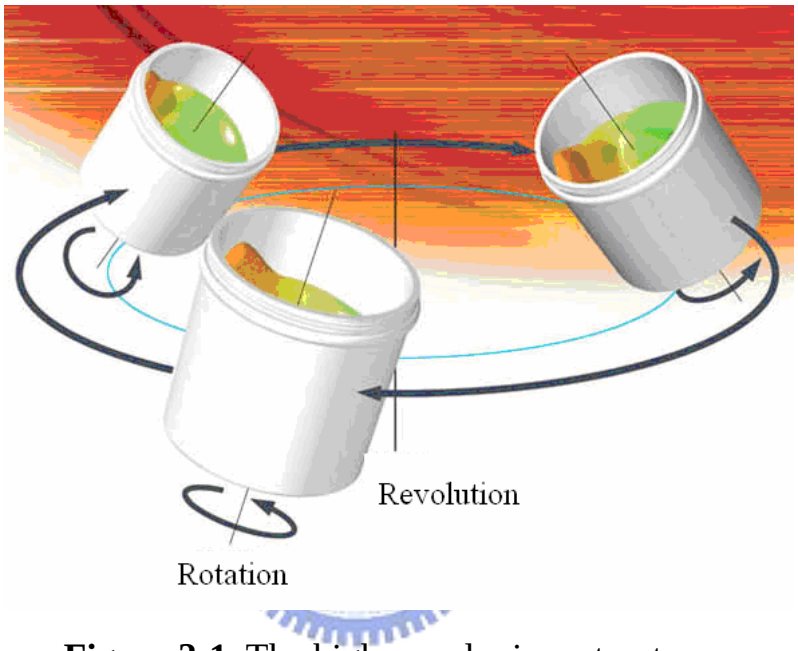

Figure 2-1. The high speed mixer structures.

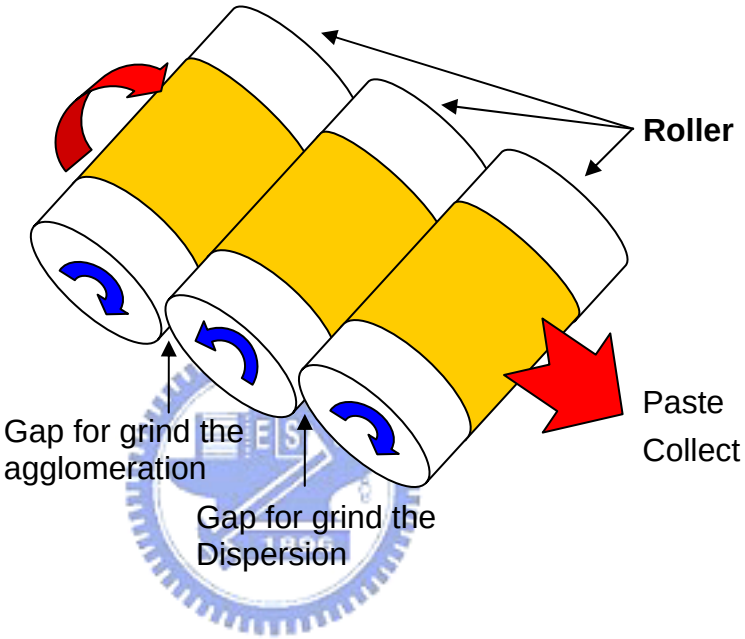

Figure 2-2. The mechanism of triple roller grinding structures.

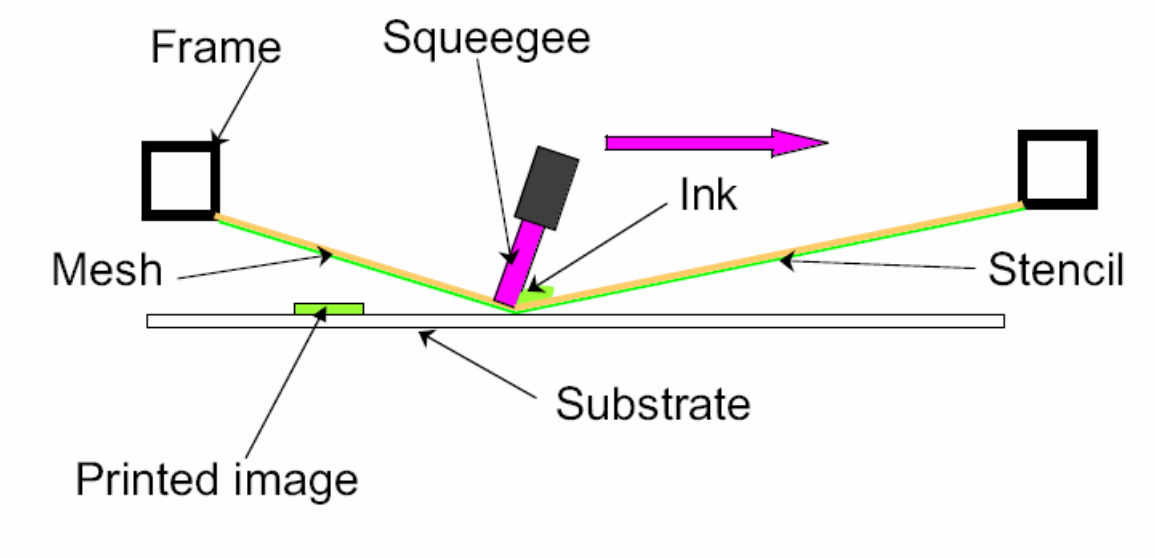

Figure 2-3. The structure chart of screen-printing.

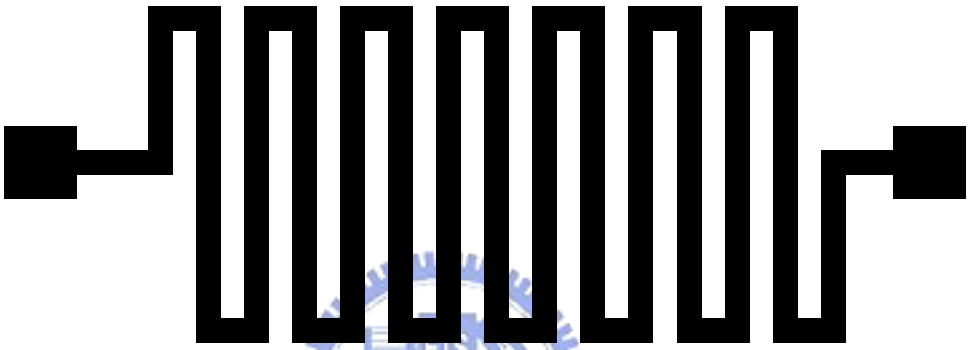

Figure 2-4. The chart of spiral line structure for resistivity measurement.

Figure 2-5. The photo of spiral line structure printing results.