

Chapter 6

Conclusion and Suggestion of Future Work

6-1 Conclusion

The typical pastes used today are based on organic solvents, like as, butyl carbitol acetates, terpineol, hydrated castor oils in combination with rheological additives, like as, pine or fish oils. In this study, develop the low curing temperature and high conductivity silver paste by metallo-organic compounds additions. The paste of this research is no binder and glass frit addition and used in roll-to-roll printing method and screen printing method.

The metallo-organic compounds were combined with the flake silver powder for use in low curing silver paste. Among the various MOD agents, the silver 2-ethylhexanoate possesses the lowest decomposition temperature (190.3°C), which forms metallic silver particles to promote the linking of the flake silver powders and thus reduces the resistivity down to $<10\mu\Omega\text{-cm}$ at the temperature as low as 200°C. The paste with 5wt% of silver 2-ethylhexanoate additions is the best formulation studied, which possesses shear-thinning and thixotropy properties and the resistivity of $7.8 \times 10^{-6} \Omega\text{-cm}$ after cured at 250°C, which is relatively close to the bulk resistivity of Ag. MOD silver pastes with the substitutions of silver flake by Ag_2O and AgO were performed to modify the curing conditions, while retaining good electrical conductivity. Results apparently indicate that the silver oxides effectively catalyze the organic species. For films prepared from pastes with 20 wt% Ag_2O or AgO substitutions, a resistivity less than $20\mu\Omega\text{-cm}$ was successfully achieved after being cured at

200°C for 5 min, which meets the requirements of low-temperature and high-speed manufacturing in flexible substrates. The reduced silver and the remaining Ag₂O enhance the connectivity of the silver flake and thus increase the electric conductivity of the films.

6-2 Future Work

The important future work must be conquered for lower process temperature with PET or Paper substrate application. Because the fast and low cost produce must use the fast printing method such as, ink-jet printing, gravure printing (roll-to-roll printing) and flex gravure printing for flexible electron requirement. The present developing curing temperature is between 200⁰C to 250⁰C dwell time between 5 to 30min all of higher than PET process limit temperature and must down to 150⁰C.

Second line printing resolution must be achieved. The key technology is the Rheology characteristic control for no binder addition in this paste system. Some application, such as RFID antenna is to care about the conductivity pattern line resolution for influence of frequency impedance. Other issue, for high speed printing, low viscosity and high printing resolution are requirement, the paste or ink rheology characteristic must to conform to high speed printing machine.

Final, the adhesion on the flexible substrate requirement and conductivity film soldering characteristic are important conditions for real produce of paste or ink. For example, RFID tag metal antenna pattern must solder by IC chip and the solder characteristic will affect the read distance and bending times of RFID tag. So, the metal powder package density and metal bonding phenomenon is the

important and indispensable condition for low curing temperature and high conductivity paste or ink with high speed printing application.

