High Conductivity and Low-Curing-Temperature Silver Paste

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ABSTRACT

In this studied, first, six low curing pastes were prepared from silver flake and α-terpineol and with different metallo-organic decomposition (MOD) compounds. The thermal decomposition behaviors of the pastes were performed. The microstructures and resistivities of screen-printed films on alumina substrate after thermally treated were characterized and discussed. Results indicated 2-ethylhexanoate possesses the lowest decomposition temperature at 190.3°C among the MOD agents studied, which forms silver particles to promote the linking of the flake silver powders and thus reduces the resistivity down to <10μΩ·cm at the temperature as low as 200°C.

Second, the effects of the solvent and atmosphere on the thermal decomposition behaviors of the silver 2-ethylhexanoate and α-terpenol were investigated. Low-curing-temperature silver pastes from Ag flake, α-terpineol and various amounts of silver 2-ethylhexanoate were prepared and characterized. The microstructures and resistivities of the cured films screen-printed from the pastes were examined. The results of thermal analysis (DSC, TGA, and TGA-MS) in oxidizing and reducing atmospheres reveal that thermal

decomposition is the dominating reaction during heating process of silver 2-ethylhexanoate, even though the DSC result reveals exothermic reaction for silver 2-ethylhexanoate heated in air due to oxidation. After thermal decomposition, it leave almost pure Ag particle, which is beneficial to provide the bridging between silver flake particles in the films. Based on the rheological behavior, microstructural evolution and electrical evaluation, it can be concluded that the low-curing-temperature silver paste with 5wt% of silver 2-ethylhexanoate additions is the best formulation evaluated, which possesses shear-thinning and thixotropy properties and the resistivity of 7.8×10^{-6} Ω-cm after cured at 250°C, which is relatively close to the bulk resistivity of Ag.

Finish, attempts to modify the curing conditions of MOD silver pastes through the part of substitutions of silver flake by silver (I) oxide (Ag_2O) and silver (II) oxide (AgO) were performed. DTA, DTG and XRD results indicated that the presence of residual silver oxide, which effectively catalyzes the evaporation of α-terpineol and the decomposition of the silver 2-ethylhexanoate, decreases the curing temperature and shortens the soaking time. The reduced silver and the remaining Ag_2O enhance the connectivity and packing density of the silver flake and thus increase the electric conductivity of the films. For films prepared from pastes with 20 wt% Ag_2O or AgO substitutions, resistivities of 14×10^{-6} and 19×10^{-6} μΩ·cm, respectively, were successfully achieved after being cured at 200°C for 5 min.