Abstract

The importance of the IT industry is becoming more and more prominent as it gradually changes to a non-face-to-face society after the COVID-19, and the next-generation smart devices of 5G mobile communication, micro LEDs, and wearable devices are emerging as the leading of the IT industry.

Along with the development of these devices, limitations and problems of the Anisotropic Conductive Adhesive Film (ACF) used as a connection material for Film on Film (FOF), Chip on Glass (COG), Chip on Film (COF), and Film on Glass (FOG) are emerging. [1-5]

To solve high resistance and electrical short and open problems as circuit electrodes became more and more fine the Self-Assembly Anisotropic Conductive Adhesive (SACA) was developed.

In order to transmit and process more data, low resistance of the interconnection material is required, and as the circuit is highly integrated, a bonding material that can be applied to the line width of ultra-fine circuits is required. [6] In addition, wearable devices, etc., require less damage to the circuit during bonding and high bonding reliability of the bonding portion. [7] Following this need, SACA was developed as a new adhesive material.

The conventional ACF is conductive by mechanical and physical point contact between the terminal and the conductive ball, which is a conductive particle, due to its structure, so high resistance may be a problem at the interconnection of device requiring much higher data capacities, higher data transfer speeds.

The probability of occurrence of a short or open circuit increases at connection below 20 pitch. In addition, contact with conductive balls and electrode terminals requires at least a few MPa of high pressure to be applied during bonding, which may result in damage to parts.

SACA (Self-Assembly Anisotropic Conductive Adhesive) has been developed as a new interconnection material to solve these problems.

The composition of SACA consists of conductive particles of a low fusion alloy with functional surface treatment and a polymer resin that is hardened by heat. Figure 1 shows the bonding process using SACA. First, when SACA is laminated on the lower substrate, and the upper substrate and the lower substrate are aligned with heat and weak pressure, the low melting point alloy particles first aggregate on the electrode surface by themselves and form a strong metal bond with the electrode. In order to increase the self-assembly driving power of the solder particles, the technology of controlling the surface nanostructure of the solder particles and the rheology control of the resin has been optimized. Currently, electrical connection is possible at a fine pitch of 40, and the process of bonding up to 160 ~ 250 can be used in the junction temperature range.

Conventional conductive particles, which are inorganic substances of ACF, are only involved in the electrical connection with the electrode and do not contribute at all to the bonding strength with the electrode. SACA shows a much lower connection resistance than conventional ACF, as well as the low fusion alloy particles converging around metal particles exposed to the electrode surface and then melting them together to form a strong bond with the electrodes. Figure 2 shows the cross-sectional SEM of the structure in which the upper and lower electrodes are bonded by SACA. Existing ACF shows a connection resistance of 1 to 10 Ω, but SACA shows a low connection resistance of 0.01 to 0.2 Ω.

In addition, the conventional ACF required a strong process pressure of 2 to 50 MPa or more so that the conductive ball makes sufficient contact between the upper and lower electrodes, but SACA using low fusion alloy particles causes bonding to occur at less than 3 MPa, which is a lower pressure than the pressure required for conventional ACF bonding. Therefore, damage to electrodes and devices that occurs when the next-generation substrate is bonded to the stretchable substrate and the flexible circuit board can be drastically reduced.

It is expected that SACA, a new concept adhesive material for
application of micro LED and 5G smart mobile, fine pitch circuit, and TSV bonding, which is expected to grow rapidly, will form another new market.

References


