Electrical Conductive Particles for Anisotropic Conductive Films

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TCP (Tape Carrier Package), COG (Chip on Glass), COF (Chip on Flex) are typically adopted for connecting driver IC chips for FPD (Flat Panel Display), such as LCD (Liquid Crystal Display) and PDP (Plasma Display Panel) etc. These chip packaging technologies are contributing to the realization of large display panels by the recent development of technologies to improve electronics structures. ACF (Anisotropic Conductive Films) are the major products for this packaging technology.
ACF's are hybrid conductive films which are composed of a suitable binder, and electrical conductive particles that can be selected from a variety of materials to meet specific application or specification requirements.

The diagram in Fig. 1 illustrates the use of ACF Technology for COG. ACF's are placed between the electrodes on the glass substrate and the electrodes of the driver IC. Then they are heated, pressed, and sealed. The electro-conductive particles in the ACF's are embedded inside electrodes. This packaging technology results in an anisotropic structure that is uni-directional to both substrate's and the IC's driver electrodes which become electro-conductive. However, there is no conductivity between electrodes next to each other on the substrate or the driver ICs. The ACF packaging technologies are the most suitable for fine pitch connections and one time heat-sealing for multi electrode lines. Therefore ACF's are the most efficient method for optimizing technologies used for FPD production processes.

Electro-conductive powders for ACF's can be metals coated on metal cores, or metals coated on resin cores. These particles can be produced to optimize the uniformity of particle shape, distribution and particle size, plus being able to perform where narrower pitch conditions are designed into the system. Strict control of these properties is necessary for an ACF system that will perform as required. This is especially true for particles having a CV (coefficient of variance) of less than 5%, and an average particle size of approx. 5 micron which is typical of the electro-conductive powders presently being used for ACF products. However, with the latest ACF technologies, particles are required which will have a CV of less than 3%, and an average particle size of approx. 3 micron. These particles are being used in applications having the finest pitch size. Metal and carbon particles are generally used for connections of the devices required to carry high electrical current. However, these are not suitable for fine pitch applications due to the wide particle size distribution of metals and carbons.

The metal coated resin particles for ACF consist of two materials having specific required characteristics. One is the resin core, the other is the metal coated on the core surface. The hardness and elastic recovery of resin core powders are the most important characteristics to maintain high reliability and performance. Fig. 2 shows the MCTM (Micro Compression Testing Machine) results for three different kinds of metal-coated resin powders. Suitable powder properties, being used with FPD peripherals such as metal-electrodes, substrates, and binders, etc. should be selected for meeting application requirements.

Production methods for metal-coated particles are published for both the dry process and the wet process. In order to produce a particle having uniformity, smoothness, excellent adhesion of the metal to the substrate, the electroless nickel plating has proven to be the most efficient. Additionally, in order to maintain good electro-conductivity, the electroless plating of gold on the nickel coated particles has been determined to be the best system for ACF application. The metal coating thickness and phosphorus content of the initial nickel layer are intentionally controlled to produce a particle having high electro-conductivity. This advanced electroless plating technology has been developed by Nippon Chemical Industrial Co., Ltd. [1] Nippon Chemical Industrial Co.'s new technology can produce a wide variety of metal-coated particles which can be used in a wide variety of electronics applications. Fig. 3 shows the surface of metal coated particles having a "spiky" structure with 0.1 micron bumps. [2] This unique particle surface can be made by controlling the plating conditions. The "spiky" surface on some conductive powders has been found to improve electrical contact points where the powder is being used on certain substrates.

References
1 H. Kawakami, et al.; Japan Patent, H1-242782 (1989)
2 M.Oyamada, et al.; Japan Patent, 2000-243132 (2000)

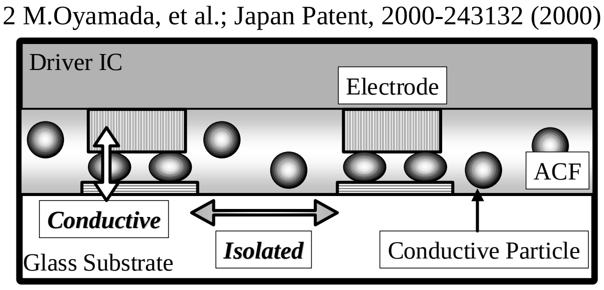

Fig. 1 Diagram of a COG using ACF technology

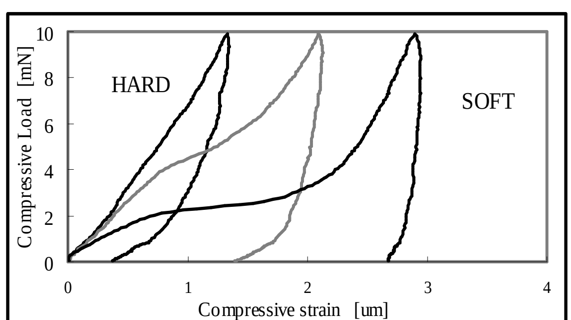

Fig. 2 Compressive property of the electrical conductive particles

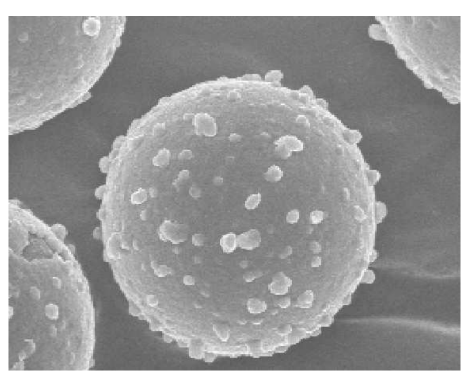

Fig. 3 SEM image of electrical conductive particles with 0.1 um bumps on the surface. Particle size is 4.6 um