Development of a Chip Bonding Technology for Plastic Film LCDs

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Abstract

A new technology realizing interconnection between Plastic Film LCDs panel and a driving circuit was developed under the processing condition of low temperature and pressure with ACFs developed for Plastic Film LCDs. The conduction failure of interconnection of the two resulted from elasticity, low thermal resistance and high thermal expansion of plastic substrates. Conductive particles with elasticity similar to the plastic substrate did not damaged a ITO electrode on plastic substrates, and low temperature and pressure process also did not deform the surface of plastic substrates. As a result highly reliable interconnection with minimum contact resistance was accomplished.

Introduction

The major trends in the electronics display today is to make products more portable by making them smarter, lighter and thinner. One of the key technologies for this kind of products is Plastic Film LCDs. It is necessary to interconnect a driving circuit with displays for reliable operation of them. With a thermosetting anisotropic conductive film (ACF) as a intermediate materials, this can be successfully achieved. However these ACFs require a high temperature for curing epoxy resins, high pressure for deforming the conductive particles. As described above, plastic substrates have low thermal resistance, high thermal expansion and softness of a surface. So, highly reliable interconnection between a driving circuit and plastic substrates is very difficult to achieve by conventional ACFs and process. As an alternative, we have investigated and developed a new process and interconnection technology that plastic substrates are not damaged by a ACF containing elastic conductive particles and a low temperature process.

Experimental Results and Discussion

Conventional chip bonding technology on glass utilizes an anistropic conductive film as an intermediate material. There are adhesives that are electrically conductive across the bond line and are electrically insulating in the xy plane. The adhesives are available in a paste form of ACAs, and in a film form of ACFs. The IC is placed into the adhesives or film and applied by pressure, ans then the film is pressed to a monolayer of conductive particles creating electrically contacts along a z-axis. However, with low-particle loading, there is no electrically continuity in the xy plane, so it is necessary to press with a high pressure which can deform the particles to minimize a contact resistance.

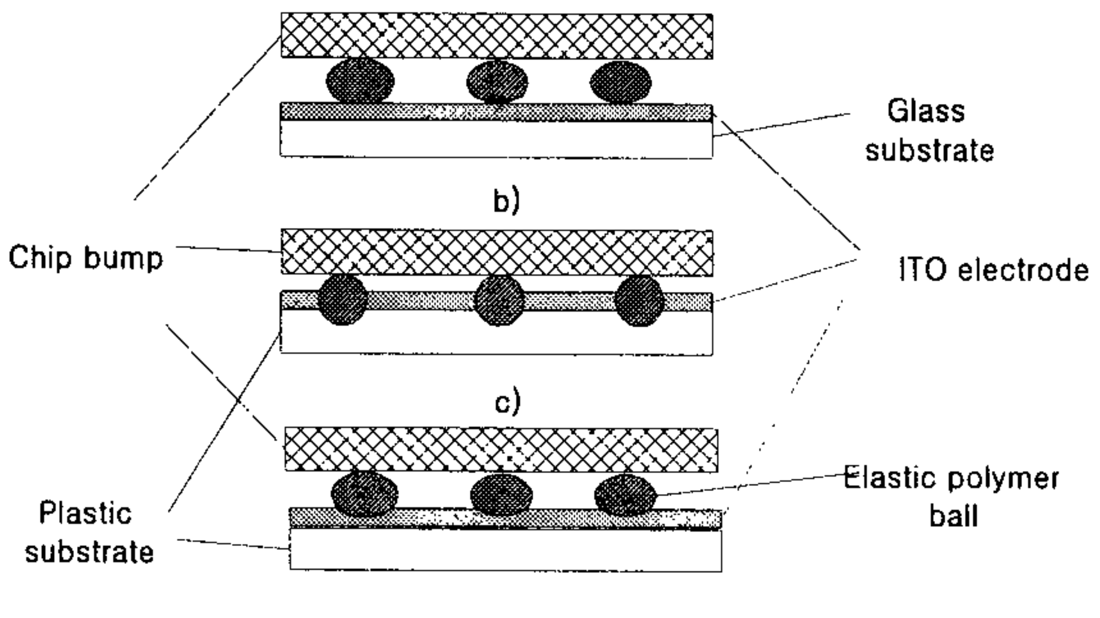

Fig. 1. Schematic view of ACF connection for glass and plastic substrates

In Plastic Film LCDs, the substrate has a low thermal resistance and elasticity. Thus, a high pressure and heat stress cracked the ITO electrode and it caused a significant increase of contact resistance. Fig.1 (a) shows conventional conductive particles deformed by a high pressure. Fig.1 (b) demonstrates that a high pressure cause the conductive particles to penetrate the ITO electrode and crack it. Fig.1 (c) shows elastic conductive particle deformed under a low pressure condition not damaging the ITO electrode. With a high pressure, an abrupt heating cycle and high temperature process are also main reasons of ITO cracks. In general, the coefficient of thermal expansion PES plastic (44ppm/K) is one magnitude higher than that of glass or ITO. It is evident from Fig 2 that a penetrated conductive ball and a heat stress cracked ITO electrode.

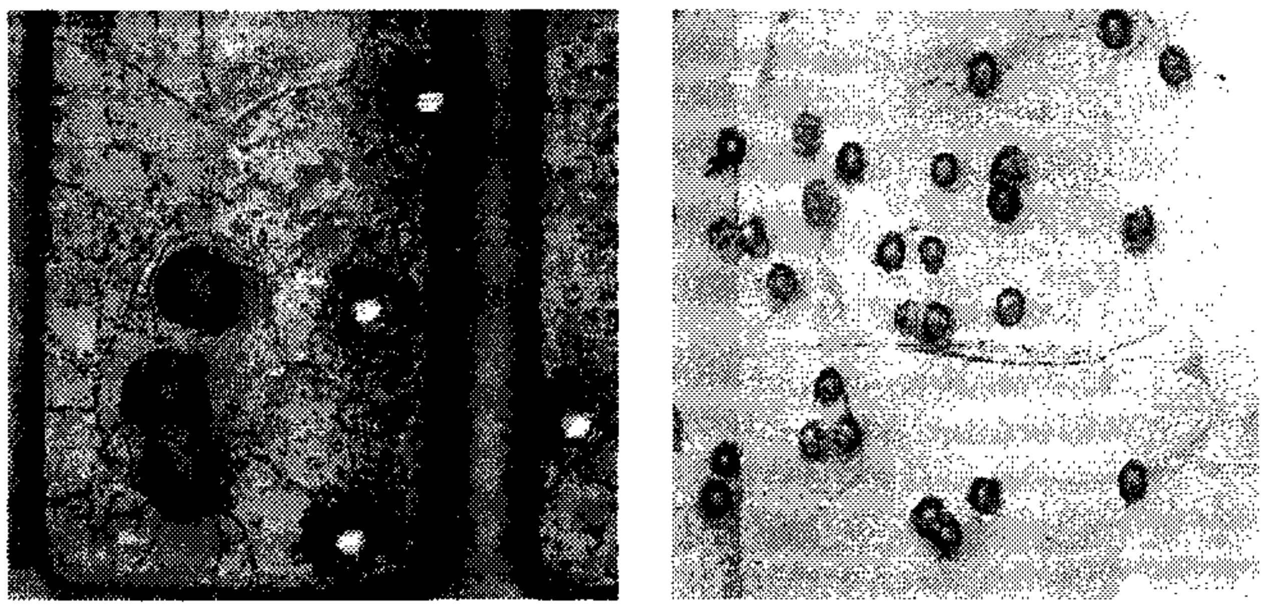

Fig. 2. ITO electrodes cracked by heat stress and penetrated conductive balls

We have experimented with various ACFs and process conditions. Table 1 lists the specifications of experimented samples. The sizes of conductive ball were 5, 7 and 10μm respectively and bump thickness was 15μm. The thickness of the ACFs was critical in maintaining uniform particle distribution. In this study an ACF thickness of 20, 25 and 30μm was found to be optimum accordingly the size of conductive particle.

Table 1. Specification of Test Samples

Substrate	Material	PES plastic substrates
	Electrode	ITO, 120 x 1500μm
IC	Bump	Material : Au
		Thickness : 15μm
		Size : 120 x 500μm
		Pitch : 250
ACF	Base resin	Thermosetting
	Conductive particle	Au plated polymer ball
		Dia. : 5, 7, 10μm
	Thickness	20, 25, 30μm

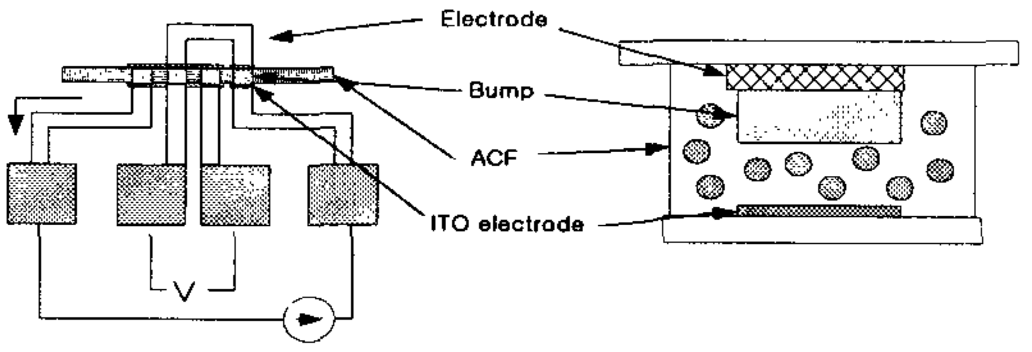

Fig 2. A schematic view of test vehicle for evaluating contact resistance

Fig 2 shows a schmeatic of contact resistance measurement. ITO electrode line with 120μm width was patterned on a plastic substrates and ACF was attached on the electrode. And then IC with 120 x 500μm Au bump was placed on this substrates and pressed with heat through many steps. We measured the contact resistance by a four point probe method.

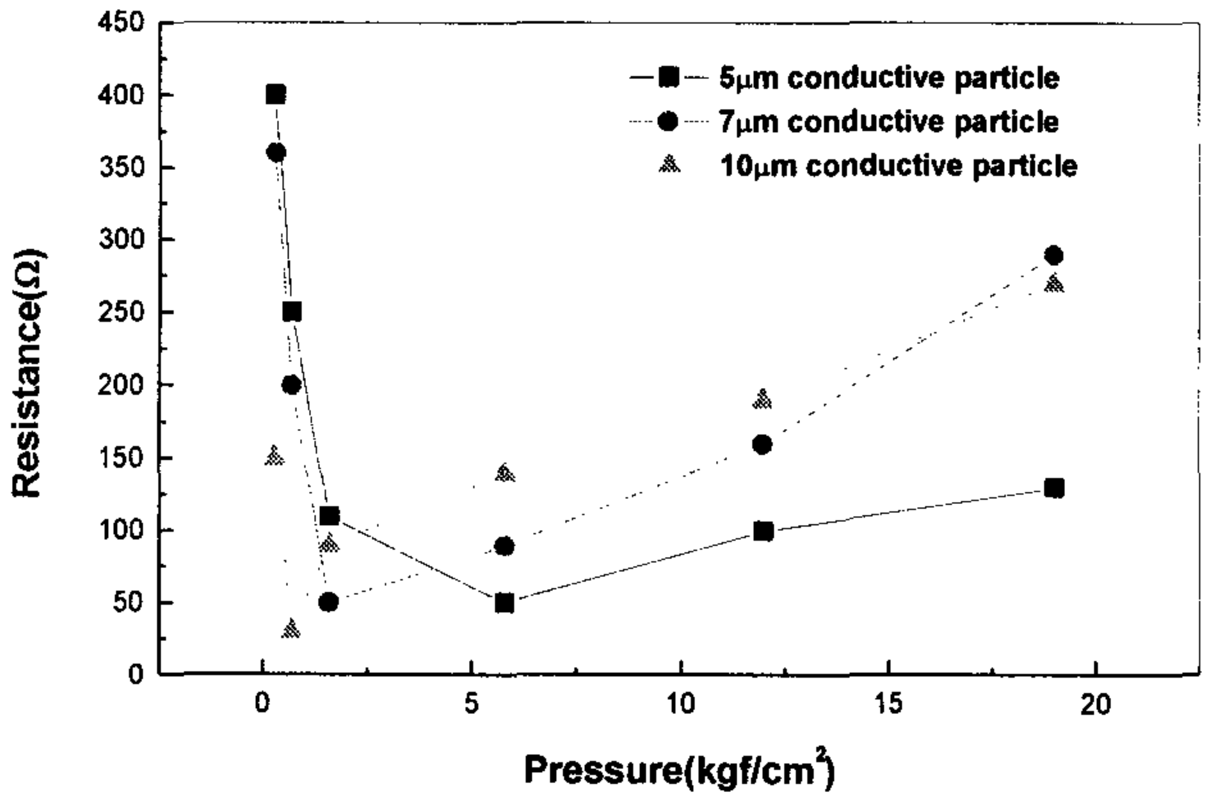

Fig 3. Resistance for a various pressure and the sizes of conductive particle

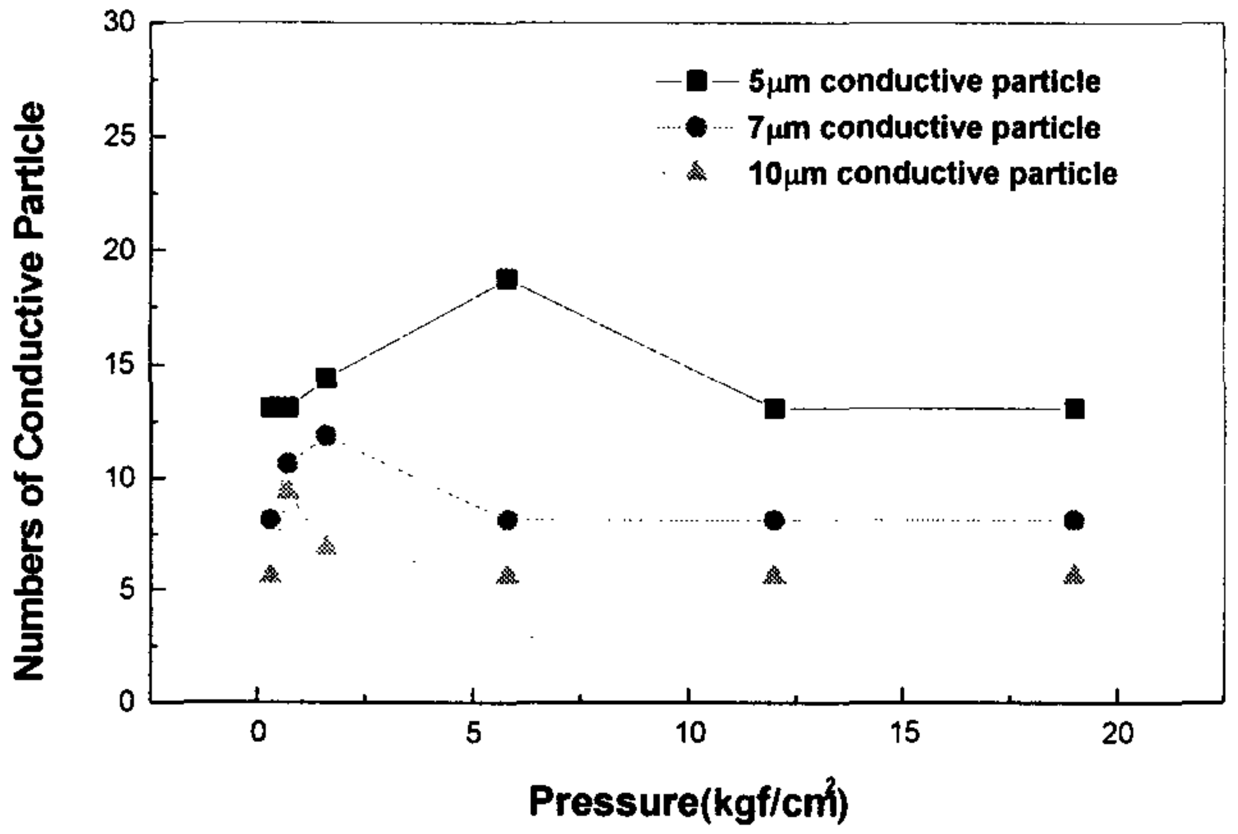

Fig 4. Number of conductive particle for a various pressure and the sizes of conductive particle

To avoid a heat stress by an abrupt heating and high temperature, a temperature cycle of the process was accomplished through several steps and limited to below 110°C. Fig 3 demonstrates experimental results. It is accomplished for various force pressure and conductive particle sizes. Fig 4 shows the numbers of conductive particles distributed on the area (120x120μm) for various particle size and pressure. Contact resistance with a conventional ACF included less elastic conductive particles exceeded this limits in all case. It was regarded as conductive particles penetrated the ITO electrodes and increased the contact resistance critically. As shown Fig.3, and Fig.4, the bigger the size of conductive particle was, the smaller number of conductive particle distributed in the interconnection area. In this study, even for a small number of conductive particles, the contact resistance was decreased in ACF with 10μm diameter conductive particles. However it has to be recognized in the choice of the particle size that a bump size and pitch are a critical factors. We have accomplished a highly reliable interconnection with a minimal contact resistance by 0.7kgf/cm² pressure and ACFs with 10μm diameter conductive particles. Fig.5. shows the operation of Plastic Film LCD connected with a driving circuit by these new processes.

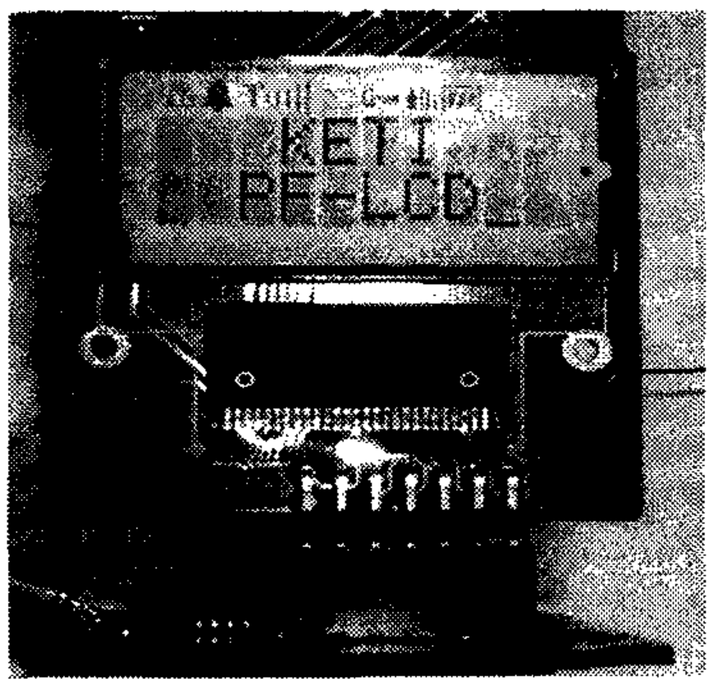

Fig 6. A highly reliable interconnection between Plastic Film LCDs and driving circuit.

Conclusion.

We have developed a highly reliable interconnection technology for Plastic Film LCDs with conductive particles improved compression transformation characteristics and new temperature process without damaging plastic substrates. Also we investigated the effect of particle size and number of particles. However it still needs to be investigated for a better improvement of the Chip On Plastic Film that epoxy resin should be cured more quickly at low temperature and conductive particles should be more elastic.

Reference

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