Electrical and mechanical characterization of an anisotropic conductive adhesive with a low melting point solder

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ABSTRACT

For the highly reliable interconnection in a micro-packaging technology requiring an excellent electrical and mechanical performance, the new anisotropic conductive adhesive (ACA) system with a low melting point solder was designed and characterized. An optimum flip-chip bonding cycle considering the chemo-rheological properties of a polymer matrix and solder was proposed. The bonding mechanism of the new ACA system was experimentally observed by the optical microscope. The electrical properties such as electrical resistance of about 5.6 mΩ and current density of 10,000 A/cm² were measured by the 4-point probe test. The measured shear strength was 304MPa after bonding process.

Electrical and mechanical performances were measured and compared before and after a pressure cooker test (PCT). In order to get a more stable ACA system during processing, the polymer matrix mixed with a reductant and a low melting point solder powder will be continuously developed in the near future.

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1. Introduction

The high density interconnections technology based on a flip-chip bonding method has been developed with a superior electrical and mechanical performance and reliability in a microelectronics packaging field [1,2]. It is generally agreed that the flip-chip bonding technology with an anisotropic conductive film (ACF) as an interconnection technology is one of the good candidates to meet the abovementioned requirements for the communication devices and consumer electronics [3,4]. For the commercial product applications, the conventional anisotropic conductive film (ACF) with a conductive particle (adhesive mixed with a polymer ball covered by conductive metal) is widely used for all kinds of passive devices such as LCD and mobile camera modules. The electrical conduction with the conventional ACF is simply achieved by the mechanical contact of a conductive particle [5]. Therefore, the conventional ACF is not adequate to use in the application field requiring a high electrical current and thermal conductance. In order to overcome those limitations, many researchers have attempted to use an anisotropic conductive adhesive with a solder powder [6-9]. Savolainen and Kivilahti had used the ACA with several kinds of solder powder [6,7]. Their bonding process was performed at several different isothermal temperatures and times under a high pressure state. In case of ACA with Sn(42)/Bi(58) of 5 vol%, the measured electrical contact resistance was about 45 mΩ before the hot and humid environment test. Recently, Kim et al. had tried to use the anisotropic conductive adhesive with a low melting point solder based on the chemo-rheological phenomena of polymer matrix and solder during flip-chip bonding process [8,9].

In the previous research [10], the new bonding mechanism with ACA composed of a polymer matrix and a low melting point solder was chemically characterized with a differential scanning calorimetry (DSC) and a dynamic mechanical analyzer (DMA) experiments [11]. From the chemo-rheological compatibility between the polymer matrix and solder, the optimum processing condition was designed and proposed to achieve the highly reliable electrical and mechanical performance. At present research, the electrical and mechanical performances were measured and analyzed.

2. Materials and experimental procedures

2.1. Materials

The diglycidylether bisphenol A (DGEBA) epoxy and dianodic phenyl sulfone (DDS) curing agent were mixed by the stoichiometric mixing ratio as shown in Table 1. Based on the previous study [10], 3 phr of a catalyst was added to get a conversion 0.8 of a polymer matrix during 5 min curing condition. For the solder system, Sn(42)/Bi(58) powder of a diameter of 45 μm with a melting point of 139 °C was used. As a reductant to remove the oxidation layer