Joining Process for Microelectronics Using Nanomaterials

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The interconnection between electronics components and a substrate is quite essential to microelectronic packaging. EU RoHS directive have prohibited lead and five other materials from being used in electrical and electric equipment from July 1, 2006. So the use of lead-free solder is expanding widely in the world. Among various lead-free solders, Sn-Ag-Cu system solders are considered the most promising for wave and reflow soldering processes. Recently, nanoparticle pastes (NPs) and electrically conductive adhesives (ECAs) have been investigated for use in microelectronics packaging and interconnections as a lead-free solder substitute due to such advantages as environmental compatibility (no lead, no flux) and low bonding temperature. NPs are only composed of nanoparticles and solvent. The self-cohesion of the nanoparticles is a significant problem in handing nanoparticles. On the other hand, ECAs are usually composed of conductive metal fillers and polymer resin. The metal fillers and polymer resins provide electrical and mechanical interconnections between surface mount device components and a substrate. For the metal fillers, silver (Ag) in various size and shapes is mainly used. However, current NPs and ECAs still have some limitations in terms of properties and processes as replacements for lead-free solder.

As one of the next-generation electronics devices, the sheet devices have attracted attention in the world. And with the sheet devices, various electronic components will be built or embedded into flexible polymer sheets. This makes it essential to develop a technology that can mount those components to the sheet at lower temperature enough to avoid thermal damage. Therefore, in our group, to address this issue, new materials and new processes have been investigated. To establish a highly reliable, advanced low-temperature joining process, surface-modified nanoparticles have been developed as a new material and applied to NPs and ECAs as a replacement for solder process. These new nanomaterials are hybrid materials composed of metal nanoparticles with low-temperature sinterability and organic protective material with flux function.

So, in this presentation, I will mainly introduce our effort for advanced low-temperature joining process using surface-modified nanoparticles for making interconnections and mounting components for next-generation microelectronics devices.