ATROX - Die Attach Using Hybrid Silver Sintering Technology

Michael A. Previti
Macdermid Alpha
Michael.Previti@macdermidalpha.com

A number of industries are developing new product-lines with innovative electronics packages that require low thermal resistance and high temperature stability, including hybrid electric vehicles, concentrator photovoltaic and wide bandgap RF amplifiers. One of the largest obstacles in the design and manufacture is the thermal management of the die and devices. Localized heat generation is the characteristic of the semiconductor chips used in these devices. For high power applications the thermal impedance of the die attach layer can play significant role in the thermal management and the operating temperature. Therefore, one would like to use the highest thermal conductivity and lowest thermal resistance die attach material that is capable for high volume manufacturing.

In a typical electronic packaging process, chips are attached to substrates and electrically connected before they are encapsulated or sealed for protection. The attachment and electrical interconnections provide the chip with an infrastructure for the flow of electrical signals, mechanical support and heat removal. The die attach materials(1) used in the packaging of high performance power semiconductors are required to have high thermal conductivity. Lead solders, eutectic gold-tin, transient liquid phase sintering (TLPS) pastes(2) and Nano-Ag sintering technology(3) are typical materials used for the die attachment of power semiconductor.

This presentation will introduce a new die attach material using hybrid Ag sintering technology. Power semiconductor packaging engineers are looking for Pb-free alternatives to traditional high Pb solder die attach paste and wire. Lead solders have respectable thermal conductivity of 30-50W/m-K, but have known process difficulties in high volume mass production such as voiding, bond line control, and the requirement inert gas (Nitrogen or Forming gas) environment. Lead is now categorized as hazardous substance to human body and environment with products containing lead scheduled to be banned. Ag epoxy paste used in standard semiconductor packaging is another die attach technology but its thermal conductivity is not high enough for Power devices. Ag sintering materials have become an attractive alternative for power devices because they possess high thermal conductivity (150~200W/m-K) achieved through solid state diffusion or "silver sintering". Most often high bonding temperature and pressure are required to achieve a high reliability joint when silver sintering technology is employed. Similar to soldering, Ag sintering technology requires backside metallization due to slow diffusion into bare silicon. Hybrid Ag sintering is composed of micron size silver powder and an organic phase. This technology overcomes the limitations of conventional Ag epoxy and Nano-Ag sintering products by using the unique design of polymer composition. The unique organic and polymer composition facilitates Ag sintering / diffusion bonding at relatively low temperatures

(~200°C) compared with sintering silver and enables up to 150 to 200W/m-K thermal conductivity without pressure during cure. The polymer enables adhesion to a variety of surfaces, bare silicon, gold and silver metalized die and silver and copper metal surfaces. The viscosity of hybrid Ag sintering product is similar to standard Ag epoxy paste and its application process is as easy as conventional silver epoxy die attach paste. Hybrid Ag sintering paste can easily drop into existing commercial die bonders and dispensing, jetting equipment to serve as a ‘drop-in’ replacement for soft solder die and epoxy adhesives.