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RELIABILITY AND MATERIAL CHARACTERIZATION OF SINTERED AG DIE ATTACH ON VARYING NITROGEN LEVELS FOR HIGH TEMPERATURE MICROELECTRONIC APPLICATIONS

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ABSTRACT

With the implementation of the RoHS directive in 2006 to ban the use of high lead solder, R&D efforts are in full scale to look for alternative materials for semiconductor interconnects. Sintered Ag has gained attention as a replacement for high lead (Pb) applications due to its high thermal, electrical and reliability performance. Today, the temperature requirements for certain business units necessitates higher levels of capability. Coupled with the pressures of converting to lead free, a feasible solution needs to be reached soon. This led to the formation of the DA5 (die attach 5) consortium in 2010. This was composed of semiconductor companies NXP, STMicroelectronics, Freescale, Infineon and Bosch. The main purpose was to look for alternative materials that can support application requirements exceeding the capabilities of solders. Although lab scale tests shows that sinter Ag can be an alternative, limited data is available on sintered Ag performance integrated with high power device applications. To validate this gap, samples were assembled with sinter Ag die attach material using a Zener diode housed on a clip package. The experimental method was divided in two phases: material characterization at varying amounts of N2 and reliability phase which subjects these units to Temperature Cycle, Highly Accelerated Stress Test (HAST), and Autoclave. All samples underwent normal assembly except for the sintering process which is necessary for silver die attach to achieve solid state diffusion. Microstructure analysis of sinter Ag die attach results into denser formation of sinter Ag paste when subjected to low N2 concentration. Die shear results were highest at low N2 concentration due to increased grain boundary formation over the sinter Ag matrix. However, low N2 concentration leads to copper oxidation which is detrimental on surface adhesion between the lead frame and mold compound. This was observed during the characterization step wherein oxides were formed on the lead frame surface. Subjecting the copper lead frame with gross oxide formation led to failures at autoclave test. Scanning acoustic tomography reveals gross separation of lead frame to mold compound interface. Also, we have determined that silver migration is a key failure mechanism for sinter Ag die attach when subjected at high N2 concentration. The reliability results for mid and low N2 sintering atmosphere show resistive effect on Ag migration. The overall outlook for Sinter Ag based on the current experimentation suggests that sinter Ag could be a viable solution for high temperature microelectronic applications.

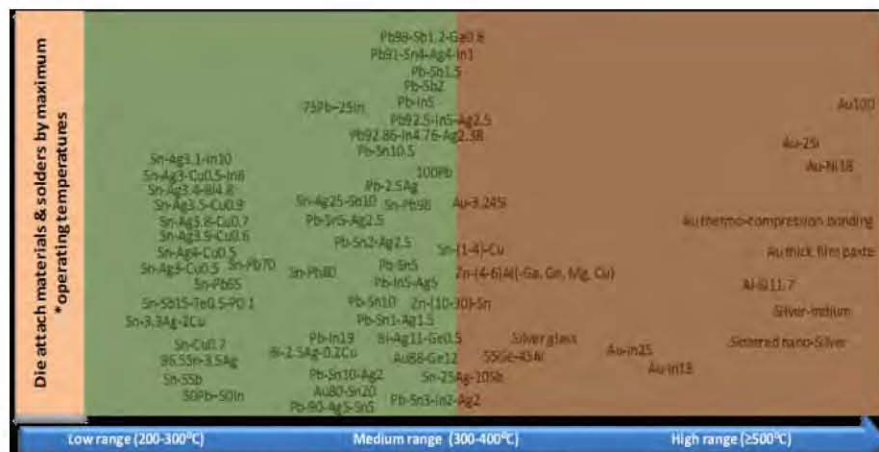


Figure 1. Thermal conductivities of various solder material interconnect [5]

Keywords: Sintering, Silver, Die Attach, Lead Free, DA5, Semiconductors, Reliability

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