Energy & Eco-Sustainability using Pressure-less Silver Sintering for RF Power Electronics

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Silver Sintering technology has been around since the 1980s, but the application has been previously restricted on account of numerous problems associated with its use. New materials, shifting demand, evolving technologies, issues of energy and eco- sustainability, together with lead-free requirements, have led many to revisit these challenges. In the past two years Palomar has undertaken a number of projects to explore various potential solutions. This paper pays special reference to our work on packaging and assembly die attach using pressureless silver sintering die attach at high temperature (>300C) with a view to its application in RF power electronics, and more especially in 5G wireless, automotive sensors and solid state cooking. As areas of significant future demand, the effectiveness, consistency and reliability of the solutions we have identified are underscored by their packaging ease and performance superiority. Extant research has highlighted a range of problems encountered by manufacturers, many confirmed in conversation with our customers. These include an uneven fillet, spill outs, shorts, strength issues and voids. When it came to creating solutions, the challenges we faced included identifying the right variables, securing repeatability, speed, and quality. Beyond these technical issues were demands from performance standards represented by earlier and alternative methods. The former set the bar of expectation, the latter raised it. Finally there were additional factors relating to future application needs and growing commercial imperatives. Historically, eutectic soldering has been the preferred medium of die attach for RF power because of its high temperature capabilities, widely understood performance and reliability. One clear implication is that the chosen solder material must retain mechanical performance and not require such a high melting point that the package is in any way compromised. Gold bonding alloy easily meets these criteria but faces the challenge of expense. Lead-tin is very effective offering reliability, performance and cost advantage, however, it falls foul of increasingly critical ecological sustainability. This leaves two remaining alternatives: 1.Transient Liquid Phase (TLP) bonding. 2.Pressureless Silver Sintering. Beyond thermal and electrical performance, cost, and low temperature capability, pressureless silver sintering has advantages inherent to the material and process itself. It can be sintered in the presence of air, dispensed from the same set of tools as solder, no special action is required to avoid damaging the die (as in pressured sintering) and nano-particles increase the coveted surface area much better than micro-particles and are also much more efficient in sintering. The paper concludes with a review of our comprehensive trials and solution variables utilizing silver sintering in RF power electronics die attach. Time- pressured dispensing showed sufficient low voiding, but lacked the speed and robustness required for volume production. Our adaptation of jet dispensing technologies, however, met the speed and material control demands

for manufacturing scale output. Critical to our success here was controlling the height of the bond line, which in turn proved key to mechanical stability and low voiding. Equal in importance were adapted software features guaranteeing ideal viscosity, dispense and volume rates.