APPLICATION NOTE

AuSn Die Attach

INTRODUCTION

The objective of this application note is to provide users with a guideline for AuSn eutectic die bonding of Cree’s GaN HEMT-on-SiC die. It provides recommendations based on Cree’s AuSn die attach processes that yield reliable and void free bond lines. The content provided in this application note should be used as a starting point and guideline for setting up a robust die attach process. It also provides maximum process conditions to prevent damage to the die. As variations in packaging materials and assembly processes will exist, it is recommended that users fully characterize their process to define optimal die attach conditions.

MATERIAL & DESIGN CONSIDERATIONS

A eutectic gold tin solder, Au80Sn20, with a melting point of 280°C in a preform format should be used for performing die attach. A general rule of preform size is 90% of the die metallization. When using large preform to die ratios the thickness of the preform can be kept relatively thin and Cree has found 0.007 inch thickness to be adequate. In cases where control of solder flow beyond the periphery of the die is an issue, smaller preform to die ratios can be used, but thickness may need to be increased to compensate and keep overall volume consistent.

All of Cree’s GaN HEMT-on-SiC die are produced with gold metallization on the backside and it is highly recommended that the mating surface also have gold metallization with a minimum thickness of 50 micro-inches. The preferred metallization stack of packages & carriers at Cree is 100 micro-inches of gold over 100 micro-inches of nickel. Another important factor to consider is surface roughness of the mating surface and it is recommended that it does not exceed 25 micro-inches.

The use of properly sized die attach collets is crucial to achieving void free die attach. We recommend the use of a 4 sided inverted pyramid collet when placing the die, especially when mechanical agitation “scrubbing” is used to assist in spreading of solder.

As with many assembly processes, cleanliness of the mating surfaces and the preform is essential. Cree die do not need any additional cleaning if handled properly and kept in a clean room environment. The same rule will generally apply for preforms purchased from a quality vendor. Depending on the process and environment which are used to manufacture the package, plasma or chemical cleaning can be implemented to improve the wetability of the mating surface. It is also important to keep all carriers used to transport product around as well as any other surfaces the product comes in contact with clean and free of debris and contaminants.

Copyright © 2006-2011 Cree, Inc. All rights reserved. The information in this document is subject to change without notice. Cree and the Cree logo are registered trademarks of Cree, Inc. Other trademarks, product and company names are the property of their respective owners and do not imply specific product and/or vendor endorsement, sponsorship or association.
PROCESS CONSIDERATIONS

The die attach process used at Cree and recommended to our customers is an in-situ reflow in which individual die and preforms are placed and reflowed one at a time. The process should be performed using automated equipment to attain repeatability. Reflow is achieved using conductive steady state heat or pulsed heat in a nitrogen atmosphere. Steady state heat uses a heating element that is set to a constant temperature throughout the entire process. Pulse heating uses a temperature profile much like a mass reflow process but with shorter rise, dwell and cool times. For either case, a peak temperature of 320°C shall not be exceeded. In the case of steady state heat, the die should be held no longer than 30 seconds at peak temperature. Also, the time at which the preform is held in a reflowed state prior to the die being placed should be as short as possible in order to keep Sn oxide formation at a minimum. For pulse heating, a background temperature of 200°C is a good starting point with ramp up of temperature occurring as fast as possible. The peak temperature time of a pulse heat system should be long enough to ensure the preform completely reflows and wets to the mating surfaces. This time may vary based upon the thermal mass of the package/carrier and the heating capability of the pulse heating system. Cree has found that a 5-10 second time at peak temperature of 315°C is sufficient for most internal applications. Below is an example of a typical pulse heat profile.

Preheating of die, through conductive heating, via a heated stage or collect may be employed. Cree uses a heated stage to pre-heat die to near peak processing temperatures. A pre-heat time of 5-10 seconds is adequate for most applications, but should not exceed 30 seconds.

Although mechanical agitation is not required, we have found that it aids in the wetting of AuSn and decreases voiding. Scrub patterns can vary in shape, span and the number of scrub cycles. Using a simple “+” pattern with +/- 5 mil span and 5 scrub cycles provides a good starting point. Keeping the scrub span and the number of cycles minimized will help prevent the potential of mechanical damage to the die. It is also important to note that if scrubbing and pulse heating are implemented together that the scrub should not start until after the solder has reflowed.

We do not use and do not recommend using flux during the attach of Cree die. If the recommendations above are followed, the addition of flux will not yield significant improvements in process capability. If oxides are of concern a forming gas of 95% nitrogen & 5% hydrogen can be used as a reducing agent.
Although careful control of oxygen content in the forming gas should be done to ensure oxygen levels do not exceed 20 ppm.

Cree die operate at very high levels of heat density. It is therefore important that voiding under active areas of the die should be avoided. Voiding outside the active areas is permissible and can follow MIL-STD-883, Method 2030. Inspection of die attach quality can be done through either X-ray or scanning acoustic microscopy and is highly recommended.