

Fluxless Au:Sn Eutectic Solder Attach of Hybrid Ring Frames

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Abstract

A fluxless Au:Sn eutectic soldering process for ring frame attach to thick film hybrid substrates was developed and implemented at Space Systems/Loral using a Sikama Falcon 5/C conductive furnace. The furnace's highly accurate parameter controls, minimal fixturing requirements and simplicity of operation allowed for rapid process optimization. The new process has resulted in a significantly more repeatable and consistent ring frame attach process with improved package reliability and production yields.

Introduction

Hermetic hybrid microelectronic packages are found in many high reliability aerospace and military applications. Such hybrids form the heart and soul of a satellite spacecraft, appearing in electronic circuits ranging from the power control units to the high frequency amplifiers. For these high reliability applications, hybrid components (e.g. dice, ring frames, heat sinks, etc.) are typically bonded to thin or thick film gold conductor traces using gold eutectic solders, such as Au:Si, Au:Sn and/or Au:Ge. During the 12 to 15 year mission life of a typical satellite, the spacecraft will undergo rapid temperature cycling from -180°C to 150°C . Under this condition, large thermal gradients and stresses generated within the material due to poor control of the soldering process, could damage the hybrid circuits. Imperfectly soldered die, for instance, can possess a high void fraction which under thermal cycling can cause fracture of the die¹ or, in high power circuits, melting of the solder². Consequently, the long term reliability of the hybrid units depends upon precise control of soldering processes.

The high temperature gold eutectic solder alloys or "hard" solders possess the advantages of excellent electrical and thermal conductivity, high strength and negligible creep under repetitive thermal cycling³. Unfortunately, these solders must be reflowed at extreme temperatures ($> 300^{\circ}\text{C}$) and in high purity inert atmospheres (< 100 ppm O_2). Due to reliability concerns, the solders must also be reflowed without the aid of fluxing agents, making it difficult to achieve proper wetting of soldering surfaces. For gold film substrates, the presence of Sn in the Au:Sn eutectic solder causes gold leaching^{4,5}. At temperatures of only 250°C , gold has been shown to dissolve in 60:40 Sn:Pb solders at a rate in excess of