Eutectic Die Bonding Overview

1. Introduction

MEMS-based pressure sensor die can be attached to a substrate or package with different techniques employing RTV, epoxy or eutectic die attach methods. The method will depend on the user application and pressure range needed. This application note will focus on eutectic die attach which is typically meant for high pressure applications above 150 PSI and/or applications requiring media resistance. This application note will provide a high level guidance when considering eutectic die attach for package assembly.

2. Eutectic Die Bonding Process

The eutectic process involves the soldering of eutectic alloys composed of Sn (tin), Pb (lead), Ag (Silver), and/or Au (gold). When these different metals are combined into alloys, a range of melting temperatures are created depending on the concentrations of each metal used. For example, AuSn at 280°C. The main eutectic process is going from liquid phase to a solid phase and bypassing the plastic phase using heating and cooling.

During the eutectic die attach, the substrate is heated to a temperature just below the solder’s eutectic temperature of 280°C. During the bond cycle, an incremental heating is supplied to the solder layer to promote the solder melting process. Liquified solder then penetrates both bonding surfaces, and the result is an intermetallic bond. The intermetallic bond is solidified when the temperature decreases below the eutectic temperature. The process time will depend on substrate material/size and eutectic bonding equipment.

3. Pressure Sensor Die

The backside of the pressure sensor die will have to alloy with numerous metals to form a eutectic system. The most common backside metallization is gold (Au) or with aluminum (Al). SMI offers the SM9231 Series with gold backside metallization. The backside will also have a
cavity accessing the pressure sensor membrane for pressure measurement as shown in Figure 1. This die configuration is referred to as “backside entry” where the pressure will enter the backside and not make contact with the topside metallization or bond pads.

![Backside Entry Die Example](image)

**Figure 1:** Backside Entry Die Example

4. **Substrate**

Typically, an 80/20 gold/tin eutectic is used. A preform of the eutectic is placed upon the proper pad, and the die is bonded to the substrate on a eutectic die attach machine. To minimize Thermal Coefficient of Expansion (TCE) mismatches, ceramic or kovar substrates are often used with pressure sensor eutectic die attach. The goal is to minimize stresses imparted onto the die from the package assembly. Ideally, stresses to the die should only be induced by the applied pressure onto the membrane of the pressure sensor.

5. **Benefits for Harsh Environment Applications**

Eutectic die attach creates a strong bond and is impervious to many harsh environments. For example, an automotive oil pressure application needs to withstand extreme operating temperatures from -40 to +150°C and exposure to oil and vapors. The eutectic die attach will provide long-term protection and reliability. Other die attach materials may soften over time leading to costly failures. The SM9231 provides a proven, reliable solution with eutectic bonding for the stringent automotive market.

Similarly, in the case of monitoring refrigeration pressure, the die attach bond must withstand continuous high pressure as high as 750 PSI while exposed directly to a refrigerant. The eutectic die attach provides the highest bond strength with no degradation due to bond material deterioration as with RTV and epoxy. This enables higher operating pressure ranges of 500 PSI and higher. Be careful to not exceed the proof pressure of the pressure sensor die.
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