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Customizing Processes for Hermetic Assembly Of Devices Designed for Plastic Packages (1 of 3)

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Abstract

Today's leading-edge semiconductor devices are designed and manufactured for high volume, low cost industrial and consumer based products. The design and layout of these new integrated circuits (ICs) favor plastic molded assembly with an eye toward reduced cost, not dependability. This leaves the high reliability, low volume military and aerospace applications with fewer hermetic package choices directly from the Original Component Manufacturer (OCM). The challenge exists to bridge the reliability requirements of military and aerospace communities with leading edge ICs designed for the mass market.

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Introduction

The demands of the commercial and industrial markets have driven the semiconductor industry towards miniaturization, increased yield to maximize productivity, and reduce cost. This drive for cost reduction pushes the boundaries of minimizing die size, bond pad size, and pitch. Process Control Monitors (PCMs) were found traditionally in each reticle. PCM has now moved to the scribe lines to maximize useable space for die fabrication (Figure 1.1).

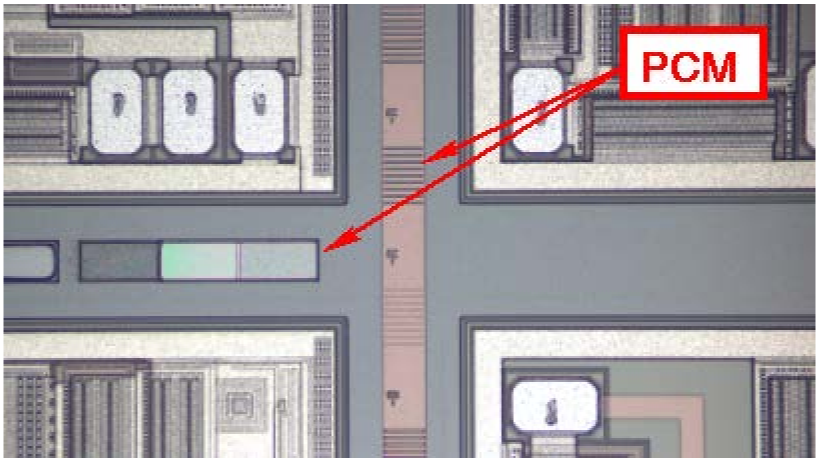

Figure 1.1: Typical PCM Location before saw

First Assembly Process Modification: Wafer Saw Experiment

The need to remove the PCM from the scribe lines can cause assembly issues with high-reliability hermetic IC packages. Hermetic packages have air cavities so loose Foreign Object Debris (FOD) generated from the wafer dicing process of the PCM can cause both optical inspection rejects (per MIL-STD-883 TM2010) and electrical failures in the field. Conductive metal from the PCM, if later dislodged, could short between bond wires, bond pads or any circuitry opening on the die surface (See Figure 1.2).

This issue does not exist in the Plastic Encapsulated Microcircuits (PEMs) as the entire die and internal package leads are encased in plastic which will trap any FOD.

Several ways exist for removing the PCM from the scribe line. One method uses a narrow saw blade (under half the scribe line width) with two shallow sawing passes and a final complete saw. The shallow cut depth is enough to remove the surface metallization of the PCM. The final step is a complete cut through the entire depth of the wafer at the middle of the scribe line. This process employs a single blade allowing the use of the same saw station without any blade changes or removal of the wafer from the saw equipment.

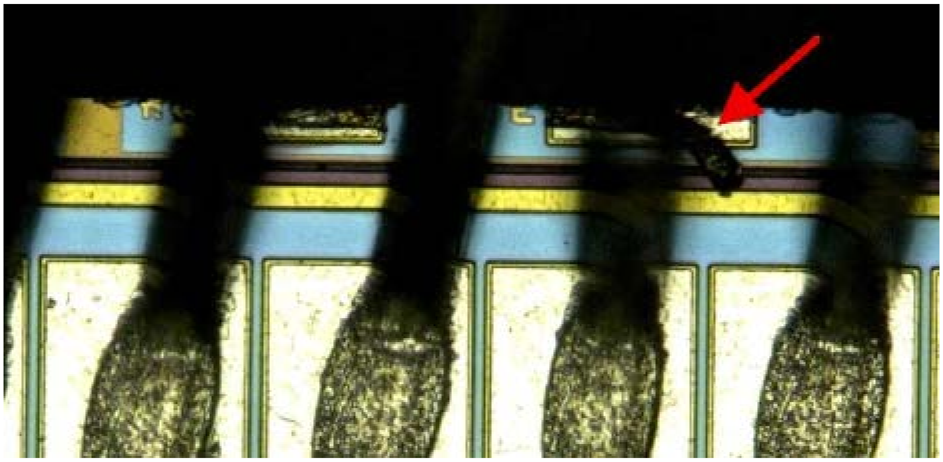

Figure 1.2: Residual metal from PCM

A variation on this method calls for the removal of the PCM with a saw blade as wide as the PCM and at a cut depth just below the PCM metallization. The final cut uses a standard saw blade with exposure greater than the wafer thickness and a blade width under half of the scribe line width. This method requires the use of two different saw stations. The wafer must be removed from the wider blade station and mounted on the saw station with a thinner blade.

An alternative method uses a saw blade just as wide as the PCM metallization and cuts in a single pass. This method saves time as it's just a single cut. Drawbacks to this process include the need to slow down the saw cut speed and constant monitoring of the cut to avoid any blade wobble or equipment drift.

In this particular example, a 2830 blade was used (see Figure 1.3). This blade selection matches the PCM metallization on this particular step pattern. The PCM is 2.65 mil wide, so 2.8 mil wide blade will completely remove all PCM metallization.

Figure 1.3: Top view of alternative method

Issues With PCM Removal

Figure 1.4 shows an example of blade wobble using a 3030 blade. While not a concern for commercial grade part, this chipping will not pass muster in the high-reliability world. In this example, the initial blade selected for PCM removal was much wider than the PCM. Reduction of the saw cut speed can help decrease blade wobble, but with other trade-offs. Reducing the blade thickness from 3 mils to 2.8 mils adds another level of security as there is now additional room for error.

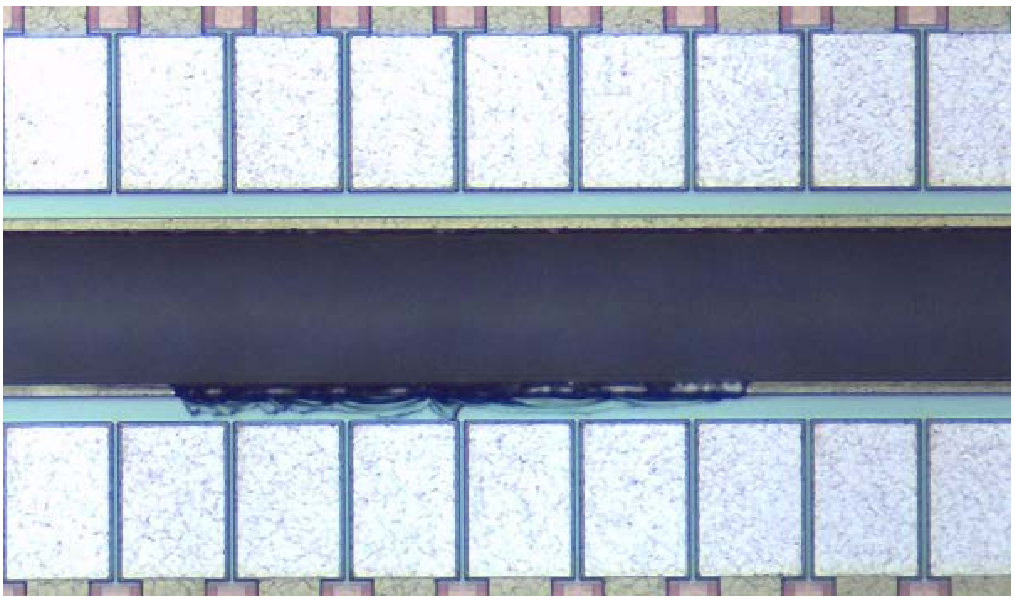

Figure 1.4: Blade wobble developed using 3030 blade at normal cut speed.

Wafer Saw Results

Eliminating the saw street PCM with the use of blades wider than the PCM works, but the drawbacks include longer processing time (slow table speed) and increased silicon dust on the exposed bonding pads (see Figure 1.5).

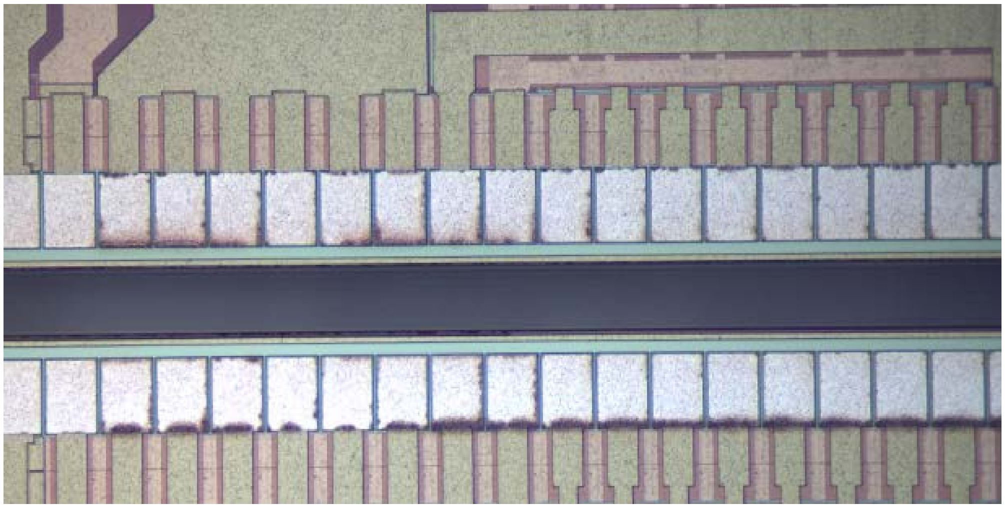

Figure 1.5: Heavy silicon dust reduced table speed and cut volume