Tin Sputter Caused by Plasma Cleaning and its Affect on Wirebond Quality

Joseph Fauty, Joseph Sauvageau, Steve Strouse, Marvin Selby, Mark Maxwell, and Mark Sandifer
Motorola SPS
1300 North Alma School Road
Chandler, Arizona 85224
Phone: 602-814-4994
Fax: 602-814-4147
e-mail: p12936@email.sps.mot.com

Abstract

The advent of mixed technology multichip module processing, issues not normally encountered in standard chip and wire processing, have been identified. One such issue is tin sputter during plasma cleaning. Tin layers as thin as 20 to 30Å can inhibit wire bonding. In massive quantities, tin can cause electrical shorts between pins in PGA devices or between bond pads on IC chips if deposited across the glass dielectric. In this paper, a problem associated with tin sputter during plasma cleaning of a mixed MCM technology is reviewed. This paper discusses issues surrounding tin sputter and illustrates the way these issues relate to processes designed for standard COB wirebonded product. Argon is shown to be incompatible with soldered components due to tin sputter. A series of screening experiments conducted to determine a more robust method of cleaning product without exposure to tin sputter showed oxygen to be a viable alternative for cleaning gold metal plating without degrading wirebond quality nor adversely affecting epoxy overcoat adhesion to solder mask.

Key words:
Tin Sputter, Plasma Cleaning, Wire Bonding, and Mixed MCMs Technology.

1. Introduction

As multichip module designs become increasingly common, “Mixed Technology” processing utilizing both standard tin-lead Solder Surface Mount (SMT) and microelectronic Chip On Board (COB) techniques on the same module are being introduced. One such Multichip Module is Motorola’s Optobus™ fiber optic data link. Figure 1 is a photograph of the unencapsulated Optobus™ module showing the chip and the wire on the inside of a hard-wall dam and the Optical Interface Units (OIU) on the outside. Figure 2 shows the module after overcoat encapsulation and OIU cover attach. The module is a 102 pin through hole PGA, Bismaleimide-Triazine (BT) laminate consisting of 13 components and 192 wirebonds. A BT laminate wall wraps around the edge of the module and acts as a hard-wall dam to simplify encapsulation of the components and wirebonds. Metal pins are through holed soldered to the module with a high temperature tin-lead paste. This module is plasma cleaned twice during the assembly flow. The first cleaning prepares the substrates for wire bonding. The second cleaning enhances the adhesion of the overcoat epoxy to solder mask that covers most of the top side of the substrate.

With the advent of mixed technology multichip module processing, issues not normally encountered in standard chip and wire processing have been identified. One such issue is tin sputter during plasma cleaning. Tin layers as thin as 20 to 30Å can inhibit wire bonding. In massive quantities, tin can cause electrical shorts between pins in PGA devices or between bond pads on IC chips if deposited across glass dielectric. In this paper, a problem associated with tin sputter as a result of argon plasma cleaning is reviewed. In the sections below, a general overview of the plasma cleaning pro-
Tin Sputter Caused by Plasma Cleaning and its Affect on Wirebond Quality

2. Plasma Cleaning Overview

Plasma generated components can react in various ways with surfaces. Plasma system configuration and process parameters affect the nature of this interaction. These parameters can be adjusted to coat a surface (sputter), etch either mildly to clean or aggressively to remove material, or modify a surface physically or chemically. The choice of gas to use is usually determined by the material to be sputtered, removed, or modified. For cleaning, gases are chosen such that their component species will react with surfaces to form volatile products that can be removed by the system.

The plasma cleaning systems referenced in this article are manufactured by March Instruments, Inc., therefore, some equipment parameters may be specific to their design, but the overall results can be applied to any plasma cleaning process. These systems are designed around a box concept in which multiple shelves are used. The shelves are the actual electrodes so can be powered, grounded, or floating. To create a plasma in these systems, a gas is introduced into a chamber where it flows between a positive and a negative ‘electrode set’, powered by a RF signal (DC and Microwave signals can also be employed). The gas is electrically excited by the RF, dissociates into sub-atomic particles, flows through the chamber physically hitting the surface to be cleaned. Depending upon the type of gas used, cleaning is effected either by mechanical bombardment of the surface (as in the case of argon gas) or a combination of mechanical bombardment and chemical reaction (as in the case of oxygen gas).

Depending on the shelf configuration, various forms of plasma cleaning are available. The methods employed depend on the type of cleaning desired and the sensitivity of the parts to be cleaned. These methods can be summarized as follows,

- Reactive Ion Etching (RIE, also called directional),
- Direct, and
- Downstream (also called electron-free).

RIE plasma cleaning occurs when parts are placed on the active electrode shelf. This is the most aggressive cleaning method and is usually used to anisotropically etch contaminants from a surface. Direct plasma cleaning occurs when parts are placed on any shelf inside the RF field. Direct plasma cleaning is not as aggressive as RIE and is isotropic (non-directional). Downstream plasma cleaning occurs when parts are placed on neutral shelves outside the RF field. The plasma is allowed to pass through a lower perforated electrode onto the sample. Since the lower electrode is grounded, electrons that can damage sensitive die are trapped and only the longer lasting ionic components of the plasma will migrate to the surface. This process is a gentle plasma clean used to clean thin films and it is extremely sensitive to electronic parts.

Gas pressure is the primary parameter for reproducibility of a process. Pressure determines the amount of gas present and therefore the mean free path between collisions. This affects the amount as well as the energy of ions that impact the surface to be cleaned. Increasing the amount of gas in the chamber (such as increasing the...
pressure) shortens the mean free path making molecule collisions more frequent thus dissipating the energy and reducing the cleaning effect. Also, important to the plasma cleaning process is the RF power. Increasing the power increases the kinetic energy of the gas molecules, which should enhance the cleaning effect. It must also be noted that the greater the power the higher the temperature within the plasma chamber.

3. Tin Sputter

A standard Argon plasma cleaning process developed for metal and ceramic packages/substrates and later extended to include chip and wire on organic laminates possessed a proven track record and so was specified for the new product. The one major difference between this product and all others was the presence of tin-lead solder on the same substrate. Wirebond process control quickly identified a problem with bond strength after plasma cleaning. Further investigation revealed bond strength degradation to a point of 100% flame off errors as a function of time in plasma clean. The initial hypothesis explored was a reduction in the thickness of the relatively thin gold plate (10-15 microinches pre-exposure). Figure 3 is a graph showing the reduction in gold plate thickness as a function of time when cleaned in argon gas. Although the data showed a general decrease in plate thickness with time, the results were insufficient to declare this factor as the primary cause for poor bond quality. The remaining plate thickness was more than sufficient to support gold wire bonding as long as it was free from contamination.

In addition to wire bonding, argon plasma cleaning was also specified before overcoat encapsulation to enhance the adhesion to the solder mask that covered most of the encapsulated area. A series of experiments established plasma cleaning as one of the main effects for good adhesion of the overcoat epoxy to solder mask. At no time during the experiments was there any visual indication of tin sputter. Visual evidence of massive tin sputter became evident after routine maintenance and repair of the existing plasma cleaner. The first pilot lot cleaned in the refurbished machine using normal production parameters resulted in visible tin sputter. The sputtered film manifested itself by turning all gold plating to a silver-white color and in extreme cases showed a silver-white haze on top of the solder glass on the bottom side of the modules. Further investigation of the problem also revealed that modules with sputtered tin exposed to the overcoat cure cycle resulted in tin diffusion into the gold turning the color of the plate back to a bright yellow indicative of gold. Energy Dispersive X-ray analysis (EDAX) at a low working voltage verified the contaminant as tin. Figure 4 shows an example of a module with massive tin sputter. Figure 5 is an example of an EDAX analysis of a sample unit.

**Figure 3.** Reduction in gold plate thickness (units of measure in microinches) as a function of argon plasma cleaning time. Although the data showed a general decrease in plate thickness with time, the results were insufficient to declare this factor as the primary cause for poor bond quality as a function of plasma cleaning.

**Figure 4.** Test module exposed to argon plasma cleaning for 20 minutes. The ‘dark haze’ in the upper left corner was identified as tin sputtered from the soldered pins.

**Figure 5.** SEM-EDAX plot of a gold bond pad on an argon plasma cleaned unit showing sputtered tin. The area scanned showed visible signs of tin. The tin peak can be identified on the plot.
A series of experiments were launched to investigate and address the tin sputter problem. Due to the reasons cited in the next section, a decision was made to switch from argon to oxygen gas. Since oxygen cleans both mechanically and chemically, it is inherently a faster process than cleaning with argon. One major goal of the study was to keep the exposure time as small as possible to avoid generating excessive heat, and reduce the tendency or even stop the sputtering mechanism. Another reason for limited exposure was to reduce the oxidation of silver pastes used for die attach since prolonged exposure to oxygen plasma will turn the epoxy black and may affect the bond quality.

### 4.1. Plasma Sputter Mechanism

Argon gas shows a much larger propensity than oxygen to sputter tin. The plasma formed when argon is used has two constituents: Ar⁺ and e⁻ that is positive Ar ions and electrons. Since electrons have greater mobility than ions (in any plasma), the net charge that builds up on surfaces is negative. Hence, a DC sheath is formed between the plasma and that surface. Positive species such as Ar⁺ can be accelerated across that sheath (DC potential). If the DC potential is large enough, (such as the kinetic energy must be greater than the sputtering threshold of the element to be sputtered), the ions can acquire enough energy to remove atoms from the surface.

Oxygen plasma is a more complicated collection of constituents with many possible reaction mechanisms that can occur. One reaction that occurs in oxygen that does not happen in argon plasma is the generation of negative ions. Possible reactions with oxygen (an electronegative gas) can include,

\[
\begin{align*}
o₂ + o₂ + e & \rightarrow o₂ + o₂^- \\
e + o₂ & \rightarrow o + o \\
e + o₂^- & \rightarrow o + o
\end{align*}
\]

Therefore, the primary constituents in an oxygen plasma are electrons, O₂⁺, O⁻, O⁻, O₂⁻, and O. The amount of each species will be a function of electron energies in the plasma and the RF-power supply frequency. At the standard 13.56 MHz, there are much fewer positive ion species (than with argon plasmas) to be accelerated across any sheath voltages generated. Negative ion species are not clearly accelerated across the negative sheath; hence, ion bombardment of the surface under consideration is drastically reduced from that of Ar plasmas and subsequently so is the sputtering cross section. Sputtering of surfaces in oxygen plasmas can occur, but at much reduced rates. Although no discoloration of the tin surface was noted, the free oxygen in the plasma may also oxidize the tin resulting in a “passivating” effect for any positive ion bombardment. There is no competing reaction in an argon environment that can mask the tin from sputtering.

### 4.2. Tin Sputter at Wirebond (Argon Gas)

According to Harman⁴, tin has been identified as a leading factor to bond failures. Two studies were cited⁴⁻⁵, in which tin was identified as contributing to wirebond failure. Tin thickness in the range of 20 to 30Å will significantly reduce bond quality. With aging, tin forms an oxide similar to nickel oxide that may not break up under ultrasonic agitation.

In order to confirm tin sputter as the cause of poor wirebond quality, an experiment was set up to create the original plasma process. Test modules were cleaned in Ionox detergent and die bonded according to normal process specifications. One module was set aside as a control and the others cleaned in Argon gas at 100 watts, 45% argon gas flow for various exposure times ranging from zero to 20 minutes. At each exposure interval, the test modules received 30 wirebonds of which 15 were selected at random for wire pull test. The control module was wirebonded at each exposure interval to make sure the machine was functioning properly. In every case, the modules were wirebonded as they came out of the plasma chamber. The results of the experiment are summarized in Table 1.

**Table 1.** Wire pull/ball shear test results plasma clean 100 watts, 45% Argon flow.

<table>
<thead>
<tr>
<th>Plasma Exposure (minutes)</th>
<th>Pull Strength Average (grams)</th>
<th>Ball Shear Average (grams)</th>
<th>Comments</th>
</tr>
</thead>
<tbody>
<tr>
<td>0</td>
<td>6.2</td>
<td>61.0</td>
<td>Failure mode 100% second bond break</td>
</tr>
<tr>
<td>3</td>
<td>5.4</td>
<td>58.7</td>
<td>Failure mode 100% second bond break.</td>
</tr>
<tr>
<td>5</td>
<td>5.0</td>
<td>56.3</td>
<td>Three bond attempts were NSOP. Failure mode 100% second bond break.</td>
</tr>
<tr>
<td>10</td>
<td>2.1</td>
<td>58.8</td>
<td>Machine flame off errors at every bond attempt. 18 NSOP’s. Only 4 test points were available. Failure mode 100% second bond break.</td>
</tr>
<tr>
<td>20</td>
<td>5.0</td>
<td>61.7</td>
<td>Flame off errors at every bond attempt. 9 NSOP’s. Substrate showed evidence of massive tin sputter. Failure mode 100% second bond break.</td>
</tr>
</tbody>
</table>

As expected, the wire pull strength degraded as a function of exposure to plasma cleaning. The presence of sputtered tin was visually identified after 20 minutes of exposure. Figure 5 shows one
of the sample test modules. Beginning at 5 minutes exposure, ball bond failures via Non-Stick On Pads (NSOP) started to occur and continued through the next two data points. At 10 minutes exposure, the machine flame off errors started to appear. A flame off error always occurs after the stitch bond attempt and is indicative of poor second bond quality. Repeated attempts to wirebond the sample given 10 minutes cleaning were fruitless. Only four successful wirebonds were made. Flame off errors and NSOP continued with the test module cleaned for 20 minutes, however, 21 wirebonds were successfully made, and as can be seen, the pull strength increased back up to an average of 5.0 grams. The reason may be related to the relative thickness of the sputtered tin layer and how fast it is able to oxidize. Figure 6 shows a boxplot of wire pull strength as a function of exposure time. A One-Way Analysis of Variance (ANOVA) indicated a significant difference in means only between the group tested at 10 minutes versus all other groups. The analysis indicated no statistical evidence for reduced bond quality at 5 or 5 minutes exposure, but significant difference at 10 minutes. While ball bond adhesion did not show significant correlation with exposure time; starting at 10 minutes sputtered tin did affect bond quality via NSOP (such as bond attempts).

Figure 6. Boxplot of wire pull strength as a function of argon plasma cleaning. Test modules were cleaned in Ionox detergent and die bonded according to normal process specifications. One module was set aside as a control and the others cleaned in Argon gas at 100 watts, 45% argon gas flow for various exposure times ranging from zero to 20 minutes.

4.3. Oxygen Plasma Parameter Study

Once argon gas was determined to be the root cause of tin sputter, it was decided to investigate oxygen as a cleaning species. Since plasma cleaning would be used to both clean before wirebond and later to prepare the solder mask for overcoat, and tin sputter at either process step can cause problems, it was decided to concentrate first on developing a process for overcoat adhesion. This process would then be used as a basis to determine parameters for cleaning before wirebond. To determine a robust set of equipment parameters that would result in adhesion of the overcoat material to the module and not degrade wirebond quality, (for example produce no tin sputter), a series of three small studies were performed. The first study established an area of stability for the RF plasma cloud as a function of power and gas flow. The second study consisted of using water contact angle measurements to determine a smaller area within the ‘stable’ region where reasonable cleaning times could be used (on the order of 30 to 60 seconds) for reasons cited earlier. The third experiment involved a test matrix in which samples were encapsulated and submitted for Scanning Acoustic Tomography (SAT) testing. Preliminary experiments established a contact angle value of less than 5 degrees as signifying a clean surface and a delamination rate of less than 0.05% signifying acceptable adhesion. A March PX-1000 box type system set up for direct plasma cleaning with one shelf to hold parts was used for all experiments.

In the first experiment, a test matrix was set up to view the RF cloud stability with the shelf fully loaded with product. Cloud stability was determined by visually inspecting the plasma cloud through a small window in front of the machine and examining for any bright spots denoting concentrations and noting any fluctuation in the reflected power. The maximum value the reflected power was allowed to reach was set at 5 in display units before a particular set of parameters was rejected for instability. Figure 7A shows the results of the test. From this data, an area of stability was determined and is shown in Figure 7B.

Figure 7a. Results of test matrix showing values of RF power and oxygen flow that result in stable RF plasma clouds. Cloud stability was determined by visually inspecting the plasma cloud through a small window in front of the machine and looking for any bright spots denoting concentrations and noting any fluctuation in the reflected power.

Figure 7b. Area of test matrix where the RF cloud was determined to be stable with the chamber shelf fully loaded with product. These results are based on the data presented in Figure 7a.
### 4.4. Overcoat Adhesion

A new test matrix was developed based on the stability “triangle” in Figure 7B. Water contact angle measurements were taken along with an inspection for silver tarnishing of the die attach epoxy. In all cases, the contact angle before plasma cleaning was > 90°. Table 2 presents the relevant data. Based on this data, a Table of reasonable power, flow, and time was determined as shown in Table 3.

**Table 2. Contact angle as a function of Oxygen plasma cleaning.**

<table>
<thead>
<tr>
<th>Power (watts)</th>
<th>O₂ Flow (%)</th>
<th>Time (s)</th>
<th>Contact Angle (°)</th>
<th>Silver Tarnish</th>
</tr>
</thead>
<tbody>
<tr>
<td>60</td>
<td>20</td>
<td>0</td>
<td>&gt;90, &gt;90, &gt;90</td>
<td>None</td>
</tr>
<tr>
<td>10</td>
<td>46, 46, 50</td>
<td></td>
<td></td>
<td>None</td>
</tr>
<tr>
<td>20</td>
<td>7, 11</td>
<td></td>
<td>Very slight</td>
<td>Tarnish</td>
</tr>
<tr>
<td>30</td>
<td>9, 6</td>
<td></td>
<td>Tarnish</td>
<td></td>
</tr>
<tr>
<td>40</td>
<td>&lt;5, &lt;5</td>
<td></td>
<td>Tarnish</td>
<td></td>
</tr>
<tr>
<td>80</td>
<td>30</td>
<td>0</td>
<td>&gt;90, &gt;90, &gt;90</td>
<td>None</td>
</tr>
<tr>
<td>15</td>
<td>38, 46, 49</td>
<td></td>
<td>Very slight</td>
<td>Slight tarnish</td>
</tr>
<tr>
<td>30</td>
<td>10, 9</td>
<td></td>
<td>Slight tarnish</td>
<td></td>
</tr>
<tr>
<td>45</td>
<td>&lt;5, &lt;5</td>
<td></td>
<td>Tarnish</td>
<td></td>
</tr>
<tr>
<td>80</td>
<td>40</td>
<td>0</td>
<td>&gt;90, &gt;90, &gt;90</td>
<td>None</td>
</tr>
<tr>
<td>15</td>
<td>47, 51, 48</td>
<td></td>
<td>Very slight</td>
<td>Tarnish</td>
</tr>
<tr>
<td>30</td>
<td>25, 29, 23</td>
<td></td>
<td>Tarnish</td>
<td></td>
</tr>
<tr>
<td>45</td>
<td>7, 10, 12</td>
<td></td>
<td>Tarnish</td>
<td></td>
</tr>
<tr>
<td>80</td>
<td>50</td>
<td>0</td>
<td>&gt;90, &gt;90, &gt;90</td>
<td>None</td>
</tr>
<tr>
<td>15</td>
<td>58, 60, 63</td>
<td></td>
<td>Very slight</td>
<td>Slight tarnish</td>
</tr>
<tr>
<td>30</td>
<td>37, 44, 38</td>
<td></td>
<td>Slight tarnish</td>
<td></td>
</tr>
<tr>
<td>45</td>
<td>19, 17</td>
<td></td>
<td>Slight tarnish</td>
<td></td>
</tr>
<tr>
<td>80</td>
<td>100</td>
<td>30</td>
<td>&gt;90, &gt;90, &gt;90</td>
<td>None</td>
</tr>
<tr>
<td>30</td>
<td>30, 21, 32</td>
<td></td>
<td>Slight tarnish</td>
<td></td>
</tr>
<tr>
<td>30</td>
<td>&lt;5, &lt;5</td>
<td></td>
<td>Tarnish</td>
<td></td>
</tr>
<tr>
<td>100</td>
<td>40</td>
<td>0</td>
<td>&gt;90, &gt;90, &gt;90</td>
<td>None</td>
</tr>
<tr>
<td>15</td>
<td>37, 36, 35</td>
<td></td>
<td>Slight tarnish</td>
<td></td>
</tr>
<tr>
<td>30</td>
<td>&lt;5, &lt;5</td>
<td></td>
<td>Tarnish</td>
<td></td>
</tr>
<tr>
<td>150</td>
<td>50</td>
<td>0</td>
<td>&gt;90, &gt;90, &gt;90</td>
<td>None</td>
</tr>
<tr>
<td>15</td>
<td>16, 17, 22</td>
<td></td>
<td>Slight tarnish</td>
<td></td>
</tr>
<tr>
<td>30</td>
<td>7, &lt;5</td>
<td></td>
<td>Tarnish</td>
<td></td>
</tr>
</tbody>
</table>

A 2³ Factorial test matrix was designed and performed according to the parameters listed below.

- In addition to the test matrix, one ‘center run’ at 90 watts, 30% flow and 60 seconds was also used.
- Two modules per test cell were encapsulated.
- All modules were batch cleaned in Ionox FCR.

SAT testing was used as the response variable with 0.05% delamination signifying acceptable adhesion. The results are provided in Table 4. The one observation that stood out is that high power (100 watts) and low time (30 s) produced superior adhesion. Since oxygen is being used, it is possible that while both 30 and 60 seconds exposure ‘cleans’ the solder mask, the higher time may be changing the surface structure adversely affecting adhesion, making it quite possible that prolonged exposure may actually reduce adhesion. Based on the observed data, the interim plasma clean parameters for the encapsulation operation were set to 100 watts, 40% O₂ flow and 30 seconds.

**Table 3. Basis for Factorial design test matrix.**

<table>
<thead>
<tr>
<th>Power (watts)</th>
<th>O₂ Flow (%)</th>
<th>Time for &lt;50° contact angle</th>
</tr>
</thead>
<tbody>
<tr>
<td>60</td>
<td>20</td>
<td>40</td>
</tr>
<tr>
<td>80</td>
<td>30</td>
<td>60</td>
</tr>
<tr>
<td>80</td>
<td>40</td>
<td>60</td>
</tr>
<tr>
<td>80</td>
<td>50</td>
<td>60</td>
</tr>
<tr>
<td>100</td>
<td>30</td>
<td>30</td>
</tr>
<tr>
<td>100</td>
<td>40</td>
<td>30</td>
</tr>
<tr>
<td>150</td>
<td>50</td>
<td>30</td>
</tr>
</tbody>
</table>

**Table 4. Scanning Acoustic Tomography test results.**

<table>
<thead>
<tr>
<th>Power (watts)</th>
<th>% Flow</th>
<th>Time (s)</th>
<th>Percent delamination</th>
</tr>
</thead>
<tbody>
<tr>
<td>80</td>
<td>30</td>
<td>30</td>
<td>0.05</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td>0.03</td>
</tr>
<tr>
<td>60</td>
<td></td>
<td></td>
<td>0.05</td>
</tr>
<tr>
<td>80</td>
<td>40</td>
<td>30</td>
<td>0.00</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td>0.00</td>
</tr>
<tr>
<td>90</td>
<td>30</td>
<td>60</td>
<td>0.05</td>
</tr>
<tr>
<td>100</td>
<td>30</td>
<td>30</td>
<td>0.00</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td>0.06</td>
</tr>
<tr>
<td>100</td>
<td>40</td>
<td>30</td>
<td>0.00</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td>0.06</td>
</tr>
</tbody>
</table>

### 4.5. Wirebond Quality

Plasma cleaning experiments for overcoat adhesion had already established oxygen gas as resulting in little if any tin sputter. A simple test matrix was designed to examine if cleaning in oxygen would have any detrimental effects on wirebond quality. Test modules were...
cleaned in Ionox detergent and die bonded according to normal process specifications. In this experiment, the parameters used were those set up for cleaning prior to overcoat (100 watts, 40% O₂ flow). The exposure time was set at 0, 30, 60, 90, and 120 seconds. In every case, the modules were wirebonded as they came out of the plasma chamber. Visual inspection of the test modules after each exposure showed no evidence of tin sputter. Figure 8 shows the results of a wire pull test. As can be seen from the boxplot and verified by a One-Way (ANOVA), no statistical difference was detected in any of the groups. Bonding machine parameters were changed, so a direct quantitative comparison of this data with that collected for argon plasma cleaning (see Figure 6) may be inappropriate; however, a qualitative comparison of trends in bond quality as a function of exposure time can be made. The histogram shown in Figure 9 indicates almost no change in the failure mode mix occurring over the exposure range. While oxygen plasma cleaning did not improve wirebond quality, the important point to be concluded is it did not degrade the quality either. This means oxygen is viable as a plasma cleaning environment if needed to clean contamination prior to wirebond.

5. Conclusions

Mixed technology product using tin-lead in conjunction with COB can result in poor wirebond quality due to tin sputter during normal plasma clean processing. This paper discussed the issues surrounding tin sputter and how they relate to processes designed for standard COB wire bonded product. Argon gas was shown to be incompatible with soldered components due to tin sputter. A series of screening experiments conducted to determine a more robust method of cleaning product without exposure to tin sputter showed oxygen to be a viable alternative for cleaning gold metal plating without degrading wirebond quality nor adversely affecting epoxy overcoat adhesion to solder mask. However, the screening experiments used in this study need to be augmented with more sophisticated designs to optimize the process.
References


About the authors

Joseph Fauty received his M.S. Degree in Materials Science from the State University of New York at Stony Brook in 1975. He is a Principal Staff Engineer with Motorola SPS working in the Core Technologies Packaging Laboratory. Mr. Fauty has 23 years experience in hybrid and MCM process technology. He is a member of IMAPS and IEEE Societies.

Joseph Sauvageau received his Ph.D. Degree in Physics from the State University of New York at Stony Brook in 1987. He has served as a Principal Staff Engineer with Motorola SPS in the Core Technologies Packaging Laboratory and as a Principal Staff Scientist at the National Institute of Standards and Technology (NIST) in Boulder, Colorado. He is currently an engineering consultant specializing in advanced packaging, process improvement, and technical research services.

Mark S. Maxwell, received an A.A. Degree from the Community College of the Air Force in 1986. He is currently a manufacturing Process Technician with Motorola’s Space Systems Technology Group (SSTG) Integral Microelectronics facility. He is responsible for constant process improvements for a wide mix of hybrid microelectronics/equipment including the Iridium program.

Steve Strouse received his B.S. Degree in Physics from Arizona State University. He is presently an MCM Producbility Engineer with Motorola SSTG. Mr. Strouse previous positions with Motorola include test, reliability, processing, failure analysis, and manufac-turing engineering. He has also worked for the ITT EPOD laboratory on PFCIT device manufacture and development.

Mark Sandifer is a Lead Equipment Support Technician with Motorola SPS working in the Core Technologies Packaging Lab. He is presently pursuing a Bachelors Degree in Manufacturing Automation. Mr. Sandifer has approximately 19 years experience in the Manufacturing Industry that includes both equipment and process automation. Mr. Sandifer current responsibilities include leading a group of technicians who are responsible for equipment and process related issues.

Marvin Selby received his A.A. Degree in Electronics Technology from the DeVry Technical Institute, Phoenix, Arizona. He is presently an Equipment Support Technician with Motorola SPS working in the Core Technologies Packaging Laboratory. Mr. Selby current responsibilities include optimization of wirebond processes on Shinkawa and K&S wirebond machines.