Uyemura's Surface Treatment Process Zeroes in on Tin

The company offers the PRESA RMK-30 immersion tin plating bath for solder treatment to inhibit whisker formation and promote outstanding soldering characteristics.

Due to the implementation of environmental regulations, the use of lead-free solders has grown on a global scale, and lead-free soldering process demands a surface with better solder wettability characteristics.

As the main ingredient of solder, tin could potentially respond to this need. However, tin's soldering characteristics may deteriorate due to heat or the use of tin may give rise to the formation of whiskers over time.

C. Uyemura Co., Ltd. has developed the PRESA RMK-30 immersion tin plating bath in order to address the said problem.

Principle of Immersion Tin Plating

According to the ionization tendency, tin will normally not deposit onto copper since copper is more noble than tin. However, in a system with an appropriate complexing agent, copper and tin complexes are formed, and the deposit potentials of these complexes will be reversed. Therefore, tin can deposit onto copper.

During the immersion tin process, almost no whiskers are being generated. The process exhibits high resistance to heat and inhibits penetration into the solder resist. The immersion tin plating demands short treatment process and simple management, and does not contain either lead or fluoride. This process is also compliant with a horizontal plating equipment.

External Features of Tin-Plating Film

Fig. 1 presents a scanning electron microscopy (SEM) image of the surface of tin-plating film. A wedge-shaped large crystal grain was observed on the surface of a tin coating as a result of using the conventional plating bath. This crystal grain was observed for the coating with a thickness of 1μm or larger, and grew in proportion to the increase in coating thickness. In contrary, when the PRESA RMK-30 immersion tin plating bath was used, a uniform tin coating was achieved, and a dense film was formed.

Treatment Process

The treatment process includes the pretreatment of the copper base and the immersion tin plating. The whole treatment process takes about 25 to 30min to complete (See Table 1).

Table 1: Treatment process with temperature and time requirement

Process	Main compound used	Temperature	Duration
1. Cleaner	ACL-007	50°C	5 minutes
2. Hot-water rinse		50°C	1 minute
3. Soft etching	100g/L SPS	30°C	1 minute
4. Acid rinse	5% H_2SO_4	Room temperature	1 minute
5. Strike tin plating	RMK-30	30°C	30 seconds
6. Immersion tin plating	RMK-30	70°C	12 minutes
7. Hot water rinse		50°C	1 minute

Dealing With Whisker Growth

The whisker is a whisker-like tin metal, single crystal formed on the tin-plating film. The formation of whiskers may cause short circuits among neighboring fine line patterns, and serves as a key issue to be addressed in applying tin plating.

A whisker will not be formed right after plating. As tin and the copper base react over time, a Cu_6Sn_5 intermetallic is formed. This will, in turn, generate compressive stress within the coating, and a whisker will grow to mitigate the accumulated compressive stress.

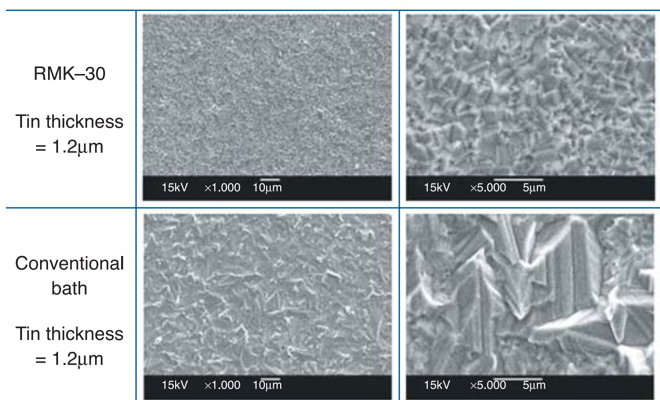

Fig. 1: A tin-plating film under a scanning electron microscope

Table 2: Whisker generation on different silver contents in tin coating.

Ag% in film	1 week	2 weeks	1 month	2 months	3 months	4 months
Without Ag	No whisker	One or more tin whiskers (Long and many)				
0.1wt%	No whisker	One or more tin whiskers (Long and few)				
0.3wt%	No whisker		One or more tin whiskers (Short and few)			
0.5wt%	No whisker					
1.0wt%	No whisker					
2.0wt%	No whisker					
3.0wt%	No whisker					

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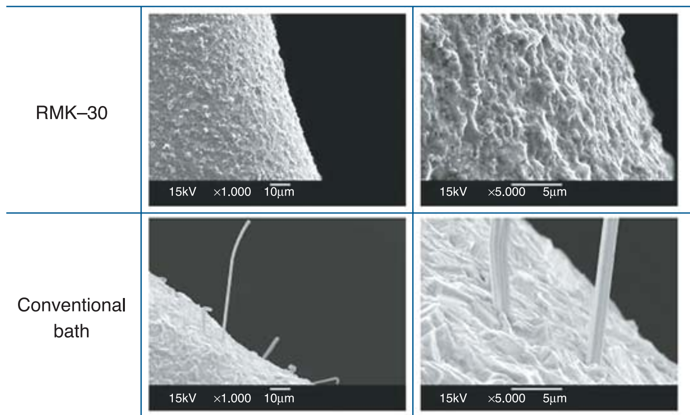

Fig. 2: An SEM image of the tested part

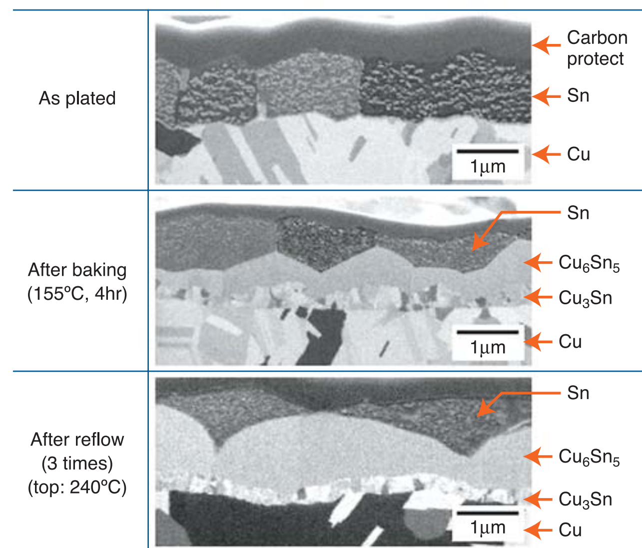

Fig. 4: The cross section of a part observed after various load tests

It has been well known that different kinds of metal are co-deposited in the coating in order to reduce the whisker growth. The assessment results of Uyemura proved that silver is the most effective among different kinds of metal used. The RMK-30 was used as an immersion tin plating bath that enables the co-deposition of a slight amount of silver. The team evaluated the growth of whiskers by using tin coating with varying ratios of silver content. The results are shown in Table 2 and a SEM image of the part examined is shown in Fig. 2.

It was confirmed that a whisker was formed on the coating without silver two weeks after plating, while a whisker did not occur on the coating with silver co-deposited after a lapse of about four months.

It was also explained that a silver content ratio in the tin-plating film had to be at least 0.5 weight percent. The higher the silver content ratio in the tin coating, the more effective the whisker growth was reduced. However, this process has its downside, including slower speed of depositing tin and an increase in the cost of coating. Uyemura considers silver content ratios between 1 and 3 percent to be a reasonable range.

Soldering Characteristics

The final surface finishing of a printed circuit board (PCB) is required in order to maintain soldering characteristics until electronic parts and components have been surface-mounted. Fig. 3 shows solder ball pull strength and the fracture mode under various load conditions.

Under any load condition, the RMK-30 demonstrated favorable soldering characteristics. Under the conventional immersion tin plating, if the number of reflow increases the soldering characteristics will deteriorate. In contrary, the use of RMK-30 resulted to favorable soldering characteristics after more than one reflow.

Fig. 4 presents an image of a part's cross section observed after various load tests were conducted. Focused ion beam (FIB) was applied in making the cross section. Even after heat treatment and three times of reflow, an adequate pure tin layer still remained, which confirmed the favorable soldering characteristics.

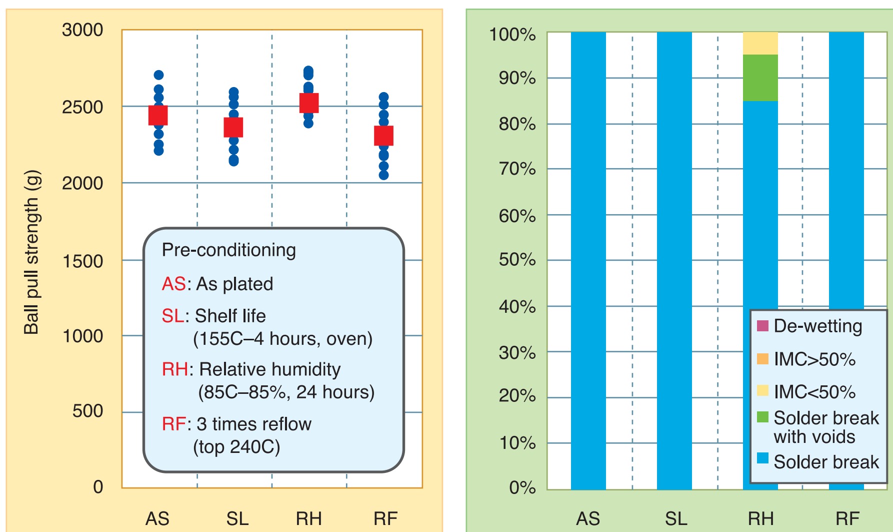

Fig. 3: Solder ball pull strength and the fracture mode under various load conditions.

Conclusion

Thanks to the development of the PRESA RMK-30, the growth of whiskers was inhibited and favorable soldering characteristics were obtained. The company expects immersion tin plating to be widely applied as one of the final surface finishing for PCBs.

About This Article:

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