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APPLICATION BRIEF

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Evaluating the heat resistance of lead-free solder containing phosphorus

1. Introduction

The use of lead-free solder has been steadily increasing as the regulation of hazardous substances by the RoHS Directive expands globally. However, lead-free solder has a high melting temperature so soldering must be performed at a high temperature. This promotes the oxidation of solder and weakens joint strength and connectivity.

The composition of solder is determined by considering various characteristics including workability, mechanical properties, and cost. However, it is crucial to examine oxidation reaction differences caused by composition when considering working conditions.

In this brief, a Thermo Gravimetry/Differential Thermal Analyzer (TG/DTA) is used to evaluate effect of additives on the heat resistance of lead-free solder.

2. Measurement

The samples were Sn-3Ag-0.5Cu solder with various amounts of phosphorous added to counteract oxidation (Phosphorous content: 0, 25, 50ppm).

The TG/DTA 6200 was used for measurements.

The measurement conditions were as follows; Sample weight: 10mg, Atmosphere: Air, Temperature: room temperature to 450℃ at 20℃/min. A sample with 50ppm of phosphorus was heated for one hour at 260℃ before being measured under the conditions listed above.

3. Results

Figure 1 shows the TG/DTA results for Sn-3Ag-0.5Cu solder with amounts of different phosphorus. In the DTA curves, all samples had a melting peak at 216℃. The phosphorus-free sample showed an exothermic peak immediately after melting (246℃). The TG curves showed a weight increase in the same temperature region, which indicates that solder oxidation, caused an exothermic reaction and weight gain.

Samples with added phosphorus repressed this oxidation exothermic reaction, which indicate the oxidation repression effect of phosphorus. Furthermore, the differences in exothermic reaction and weight gain due to oxidation in the DTA curves show that the sample with 50ppm of phosphorus more effectively repressed these reactions than the sample with 25ppm.

Figure 2 shows the TG/DTA results for a solder sample with 50ppm of phosphorus that was heated for one hour at 260℃. There was no change in the melting peak, which suggests that a soldering temperature of 260℃ would not change the characteristics of the solder. Furthermore, there was no exothermic reaction after melting, which suggests that the oxidation repression effect of phosphorus is long-lasting.

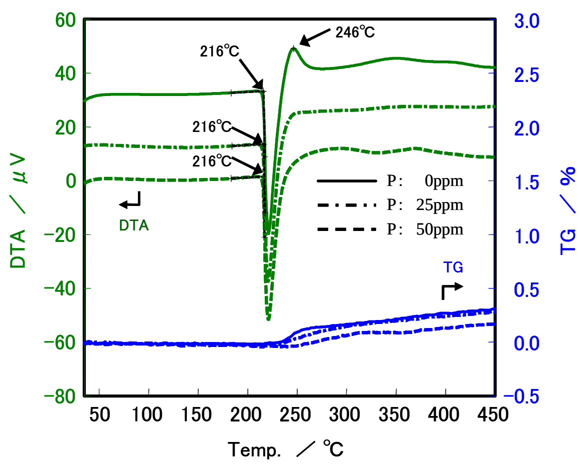

Figure 1 TG/DTA results for Sn-3Ag-0.5Cu solder with added phosphorus

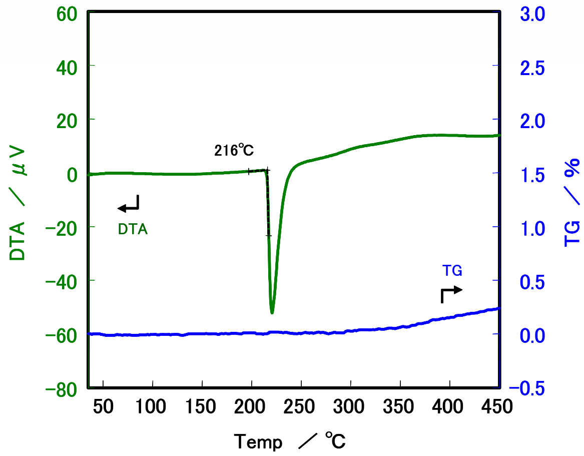

Figure 2 TG/DTA results for pre-heated solder (with 50 ppm of phosphorus)

4. Summary

In this brief, a TG/DTA was used to measure lead-free solder containing different amounts of phosphorus. The results confirmed the presence of exothermic peaks and weight gain due to oxidation. The TG/DTA measurements performed in this brief can easily assess differences in the heat resistance of lead-free solder caused by additives to repress oxidation because the TG and DTA measurements are performed simultaneously. This ability makes TG/DTA an effective tool to investigate the relationship between soldering temperatures and oxidation degradation.

Acknowledgements

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References

Application Brief TA no.74, SII Nanotechnology (2003)