Application Brief

Hitachi High-Tech HITACHI

Hitachi High-Tech Science Corporation
RBM Tsukiji Bldg., 15-5, Shintomi 2-chome, Chuo-ku, Tokyo 104-0041
TEL:+81-3-6280-0068 FAX:+81-3-6280-0075
http://www.hitachi-hitec-science.com

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Measuring lead-free solder with DSC

Evaluating the dependence of melting temperature on nickel content

1. Introduction

In recent years, the EU and Chinese RoHS Directives have expanded the regulation of hazardous substances globally. As lead-free production of electronic components becomes more commonplace, manufacturing industry is switching from traditional tin-lead-based solder to lead-free solder and researching various tin-based eutectic alloys.

The higher melting temperature of lead-free solder makes the heat resistance of mounted components is an issue. Furthermore, if components are not soldered at a temperature sufficiently higher than the melting temperature, the bond quantity is poor. Therefore, the composition of solder is determined after considering various characteristics including workability, mechanical properties, and cost. It is important to consider the working conditions when examining melting temperature differences due to composition.

In this brief, a differential scanning calorimeter (DSC) is used to evaluate how different Ni composition ratios affect the melting temperature of lead-free solder.

2. Measurements

The samples were In-35Bi-2Sn-Ni solder (Ni composition ratios: 0, 1000, 3000, 5000ppm), which has a low-melting temperature, and Sn-0.6Cu-Ni solder (Ni composition ratios: 200, 400, 600, 800ppm), which is expected to become a low-cost solder.

A differential scanning calorimeter, the DSC7020, was used. Measurement condition for the In-Bi-Sn-Ni solder was as follows; Sample weight: 10mg, Atmosphere: N_2, Temperature: room temperature to 90℃ at 1℃/min. Measurement condition for the Sn-Cu-Ni solder was as follows; Sample weight: 7mg, Atmosphere: N_2, Temperature: 160℃ to 300℃ at 10℃/min.

3. Results

3-1 In-35Bi-2Sn-Ni solder

Figure 1 shows the DSC results for In-35Bi-2Sn-Ni solder at different composition ratios. All samples showed a eutectic melting peak near 70℃. After the eutectic melting peak, a solid-phase melting peak was seen between 70 to 75℃.

Figure 2 shows the solid-phase melting peak enlarged for comparison. While the liquid-phase temperatures are similar, there are clearly differences that indicate that the higher the Ni concentration, the higher the temperature.

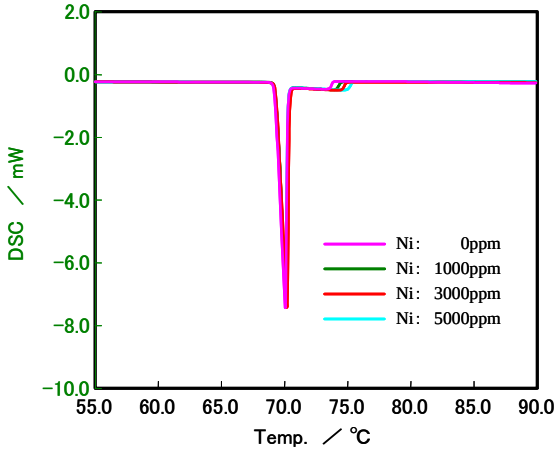

Figure 1 – DSC results for In-35Bi-2Sn-Ni solder

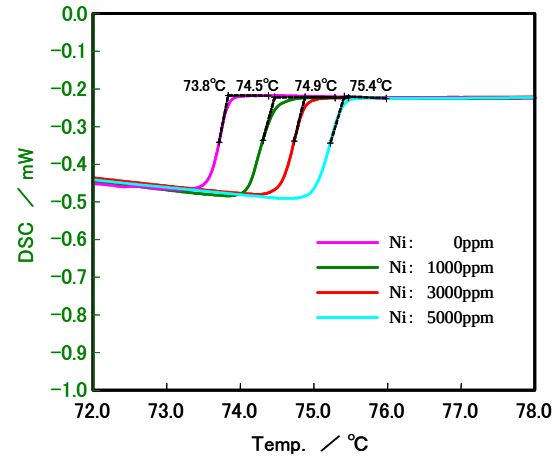

Figure 2 – In-35Bi-2Sn-Ni solder results enlarged for comparison

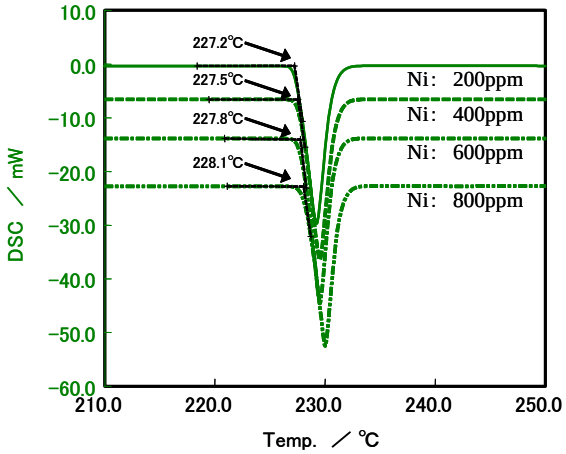

Figure 3 – DSC results for Sn-0.6Cu-Ni solder

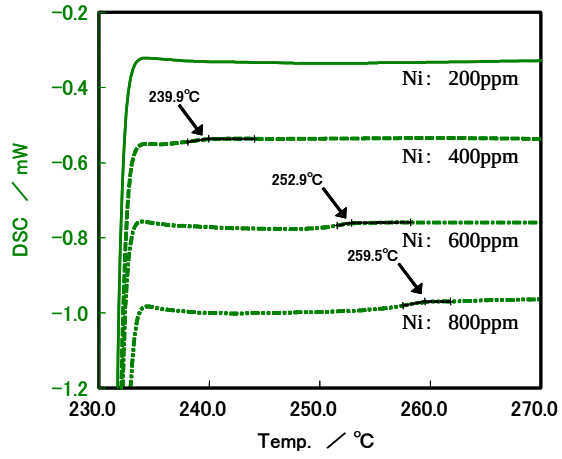

Figure 4 – DSC results for Sn-0.6Cu-Ni solder enlarged for comparison

3-2 Sn-0.6Cu-Ni solder

Figure 3 shows the DSC results for different composition ratios of Sn-0.6Cu-Ni solder. All samples showed a eutectic melting peak near 227℃. The results confirm that the higher the Ni concentration, the higher the starting melting temperature. This is true even with slight composition ratio differences. Sn-Cu composition of this solder is not eutectic so there was a solid-phase peak after the eutectic melting peak.

Figure 4 enlarges the area after eutectic peak temperature. After returning to the eutectic peak, a gradual change in the DSC curve can be seen and the liquid-phase temperature can be confirmed. Even at slight Ni concentration differences, large differences were seen in the peak liquid-phase temperature. The data shows that the higher the Ni concentration, the higher the liquid-phase temperature. If the soldering temperature is lower than the liquid-phase temperature, the solder does not sufficiently melt, which results in poor joint connections. Therefore, it is important to know how even slight composition differences affect the melting temperature.

4. Summary

In this brief, DSC was used to measure two lead-free solder types with various Ni composition ratios and verify the liquid-phase temperatures. DSC is highly sensitive and can detect melting temperature differences caused by small composition differences in the lead-free solder. DSC results can be used to determine the proper temperature conditions for soldering.

Acknowledgements

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References

Application Brief TA no.74, Hitachi High-Tech Science Corporation (2003)