Development of wettability evaluation equipment for solder paste using laser displacement method†

KOYAMA Shinji *, OYA Issei *, ISAKA Toshihiro *, SHOHJI Ikuo *,
NISHIMURO Masashi **, HIRAMOTO Kiyoshi ** and MIYAMOTO Hironaga ***

KEY WORDS: (solder paste) (wettability) (laser displacement meter) (reflow soldering) (lead-free solder) (surface mount technology)

1. Introduction

Built-in electronic parts are made minute as mobile products are miniaturized. Then, surface mount technology by reflow soldering is growing rapidly [1, 2]. Moreover, it is known that the wettability to the electrode of the solder paste is affected worsened by the world trend of Pb free in the solder paste [3, 4]. Therefore, the development of the evaluation technique of the wettability of the solder paste is a pressing need. However, the evaluation technique of the wettability of the solder paste has only a wetting balance method in which the size effect of the electronic parts can hardly be considered [5-7]. So, the development of equipment which can evaluate the wettability of the solder paste to actual electronic parts at the speed of parts in the reflow process was attempted with a laser displacement meter in this research.

2. Feature of developed equipment

As shown in **Fig. 1**, the equipment developed by this research is chiefly composed of the following three parts.

(1) The equipment has the temperature measurement system with a thermo-couple and the height measurement system of electronic parts with a laser displacement meter.

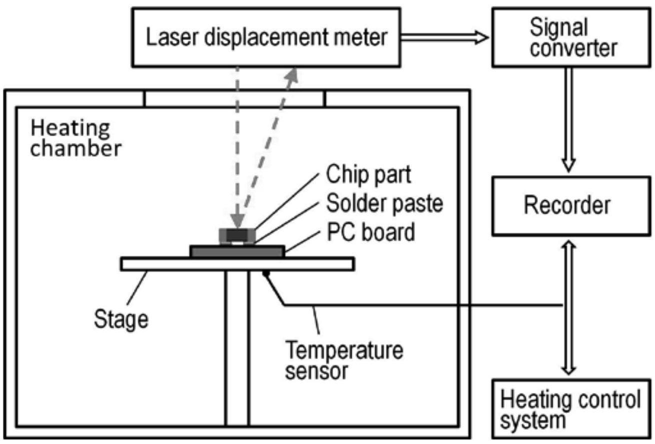

Fig. 1 Outline chart of developed equipment.

(2) The equipment has a system which can take a picture of continuous animation of joints with CCD camera in the reflow process.

(3) The equipment has a system which controls the temperature with the halogen heater and a system which controls the cooling speed by introducing atmosphere gas into the chamber.

3. Results and discussion

Figure 2 shows the heat pattern in reflow process used. The shape of the metal mask and copper land is as shown in **Fig. 3**. The 1608 chip capacitor was used for electronic parts. The results of measuring the descent behavior of electronic parts are shown in **Figs. 4-7**.

In the case of Sn-3.0Ag-0.5Cu (mass%) solder paste, it has been understood that electronic parts descend with the melt of the solder powder as shown in **Figs. 4** and **5.** In addition, the descent of electronic parts has progressed when the molten solder was wetting up to the electrode on sides of electronic parts. Even if Sn-3.5Ag-8In-0.5Bi (mass%) solder paste was used, a similar tendency was observed as shown in **Figs. 6 and 7**. However, it was understood that Sn-3.0Ag-0.5Cu solder was longer compared with Sn-3.5Ag-8In-0.5Bi solder for the time to get to the bottom after electronic parts descended rapidly. It is thought that this factor depends on the amount of solder which is wetting up to the electrode on sides of electronic parts (see Figs. 5 and 7).

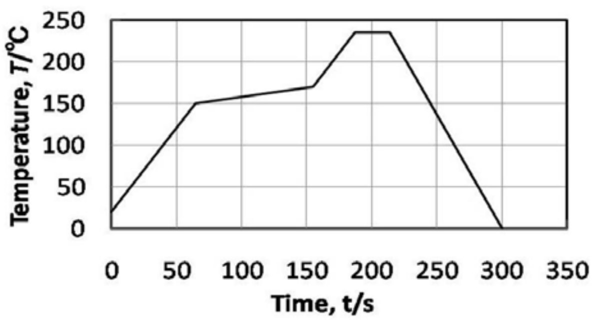

Fig. 2 Diagram of heat pattern in reflow process.

† Received on 30 September 2010
* Graduate School, Gunma University, Kiryu, Japan
** Sanyo Seiko Manufacturing Co., Ltd., Hachioji, Japan
*** Yamanashi Pref. Industrial Technol. Center, Kofu, Japan

Transactions of JWRI is published by Joining and Welding Research Institute, Osaka University, Ibaraki, Osaka 567-0047, Japan

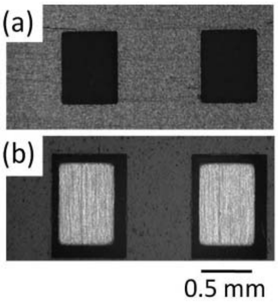

Fig. 3 Shape of metal mask (a) and Cu pad (b) used in this research.

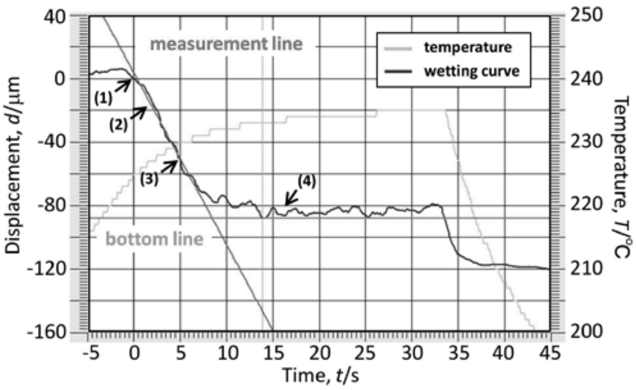

Fig. 4 Relation between descent behavior and reflow temperature of electronic parts (Sn-3.0Ag-0.5Cu).

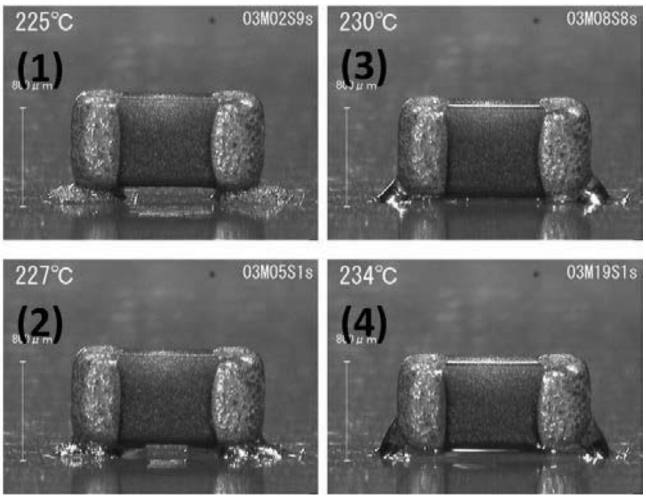

Fig. 5 CCD camera images which observed joint in reflow process. The numbers in figure correspond to those in Fig. 4.

As described above, not only the observation of the joints in the reflow process but also the analysis of the relation between the processing time and the descent amount of electronic parts (descent speed) is possible with developed systems.

An analytical result of the descent speed and the amount of the descent is shown in **Table 1**. Ten examinations were conducted for each solder paste, and the average wetting curve was obtained. From the average wetting curve, the descent speed and the descent amount were investigated.

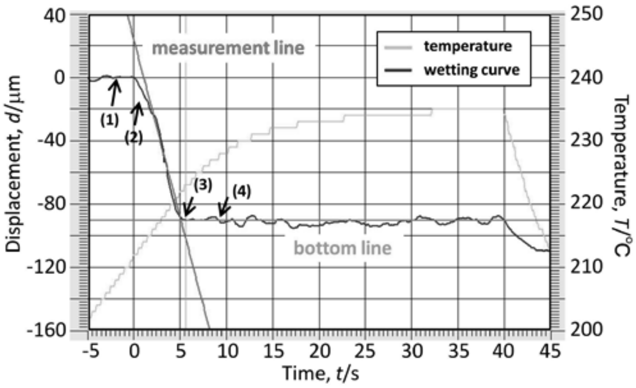

Fig. 6 Relation between descent behavior and reflow temperature of electronic parts (Sn-3.5Ag-8In-0.5Bi).

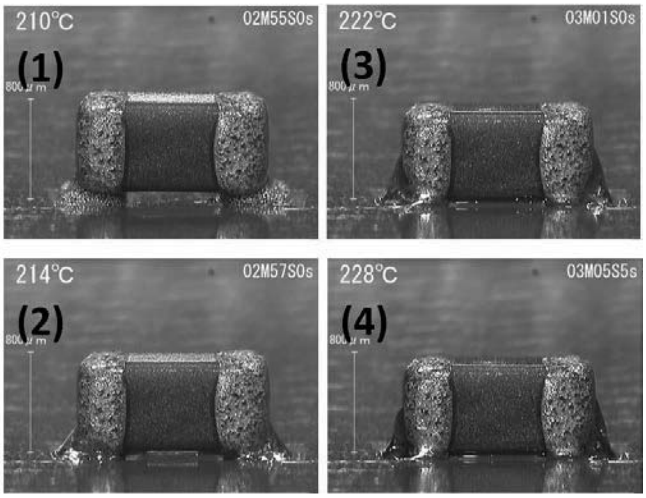

Fig. 7 CCD camera images which observed joint in reflow process. The number in figure correspond to those in Fig. 6.

Table 1 Effect of solder paste composition on descent behavior.

solder type (mass%)	descent speed (μm/s)	descent amount (μm)
Sn-3.0Ag-0.5Cu	8.7	91
Sn-3.5Ag-8In-0.5Bi	22	89

As a result of the analysis, the descent speed of parts in Sn-3.5Ag-8In-0.5Bi solder paste was twice compared with that of Sn-3.0Ag-0.5Cu solder paste although negligible change was observed in the amount of the descent of parts. The wettability of the solder paste strongly depends on the electrode type and the solder paste type. Although the evaluation of the wettability is difficult, the developed method which measures the descent behavior of the part could suggest a new evaluation technique for the wettability of the solder paste.

3. Conclusions

The conclusions of this study are summarized as follows.

(1) The wettability of the solder paste is appreciated by measurement of the descent speed of electronic parts in the reflow process with a laser displacement meter.
(2) The developed equipment can evaluate the difference of the wettability of the solder paste which depends on the solder paste type.

References

[1] B. Noh, J. Choi, J. Yoon and S. Jung: J. Alloys and Compounds, 499 (2010), pp.154-159.
[2] T. Chang, Y. Hsu, M. Hon and M. Wang: J. Alloys and Compounds, 360 (2003), pp.217-224.
[3] E. E. M. Noor, N. M. Sharif, C. K. Yew, T. Ariga, A B. Ismail and Z. Hussain: J. Alloys and Compounds, 507 (2010), pp.290-296.
[4] D. Rocak, S. Macek, J. Sitek, M. Hrovat, K. Bukat and Z. Drozd: Microelectronics Reliab., 47 (2007), pp.986-995.
[5] J. Kloeser, P. Coskina, R. Aschenbrenner and H. Reichl: Microelectronics Reliab., 42 (2002), pp.391-398.
[6] K. M. Martorano, M.A. Martorano and S.D. Brandi: J. Mater. Proces. Technol., 209 (2009), pp.3089-3095.
[7] E. Attar and C. Korner: J. Colloid and Inter. Sci., 335 (2009), pp.84-93.