WELDING STRUCTURE OF METAL SPECIMENS WELDED USING ULTRASONIC WELDING SYSTEMS WITH LINEAR AND COMPLEX VIBRATION WELDING TIPS

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Abstract

Welding area of metal plate specimens welded using ultrasonic welding system is studied. Welding specimens used are aluminum (JISA1050P) and copper (JISC1100P) plates of 0.3 mm thickness. These specimens welded using 19 kHz ultrasonic welding system are inspected using SEM and Energy dispersive X-ray spectroscopy for the purpose of observing the diffusion and the formation of an intermetallic compound of aluminum and copper.

Introduction

Ultrasonic metal welding is useful to join same and different materials with small temperature rise, small deformation and damage of the weldment, and used widely in various fields.

However there have been few studies about the microstructal behavior at the joint boundary, and that is not fully understood from the viewpoint of metallurgical engineering.

This study was carried out to understand first an information microstructual behavior at the joint surface of materials welded by linear ultrasonic vibration welding system.

Ultrasonic welding equipment and specimens

Configuration of an 19 kHz ultrasonic welding equipment

Figure 1 shows the arrangement of the 19 kHz ultrasonic metal welding equipment. The welding equipment consists of a bolt-clamped Langevin type PZT longitudinal transducer, a booster for amplifying vibration velocity, a tool horn with welding tips at the free edge and a welding frame with a static pressure source. The tool horn is driven in axial direction by a 19kHz longitudinal vibration system. The welding tip vibrates in linear vibration locus.

Welding conditions

The upper specimens are 0.3-mm-thick pure aluminum (JISA1050P), and the lower specimens are 0.3-mm-thick pure copper (JISC1100P). Vibration amplitude used is 22 μm (peak-to-zero value), static clamping pressure is 55MPa, and weld time is 0.3sec.

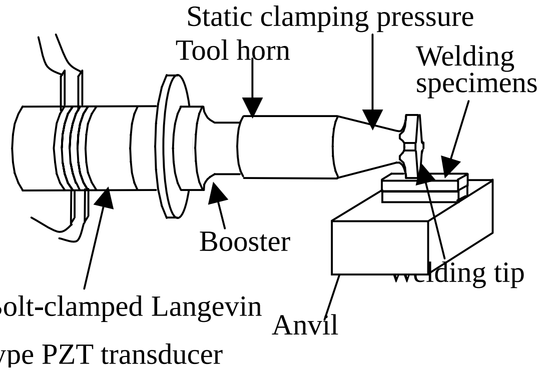

Figure1: Arrangement of a 19 kHz ultrasonic welding equipment and welding specimens

Experimental results and discussions

SEM observation

Figure 2 shows the result of SEM observation of aluminum (JISA1050P) and copper (JISC1100P) plates welded using the 19 kHz welding equipment.

The boundary of welded specimens appears clearly and provides no evidence of fusion and the formation of an intermetallic compound.

Energy dispersive X-ray spectroscopy

Figures 3 to 5 show the results of dispersive X-ray spectroscopy of the cross sections of the aluminum and copper plate specimens.

From these results, copper atoms and aluminum atoms are diffused mutually at welding surface. Especially the diffusion of copper atoms in the aluminum specimens is observed clearly. The rates of copper atoms in the aluminum and the aluminum atoms in the copper at the point 1μm off from the weld surface are respectively 25% and 6.8%.

Conclusions

(1) The SEM observation of welding boundary provides no evidence of fusion.

(2) The results of energy dispersive X-ray spectra provide no evidence of the intermetallic compound formation of aluminum and copper by the variation of these spectra.

(3) The diffusion of the copper atoms in the aluminum at the points 1μm off from the welding surface is observed clearly at the rate of 25%.

References

[1] J. Tsujino: Proc. Ultrasonics International 83, Halifax, Canada (1983) p.358-363.

[2] J. Tsujino, T. Ueoka, T. Yanagihara, and M. Takahashi: Proc. Ultrasonics International 85, London, UK (1986) p.704-709.

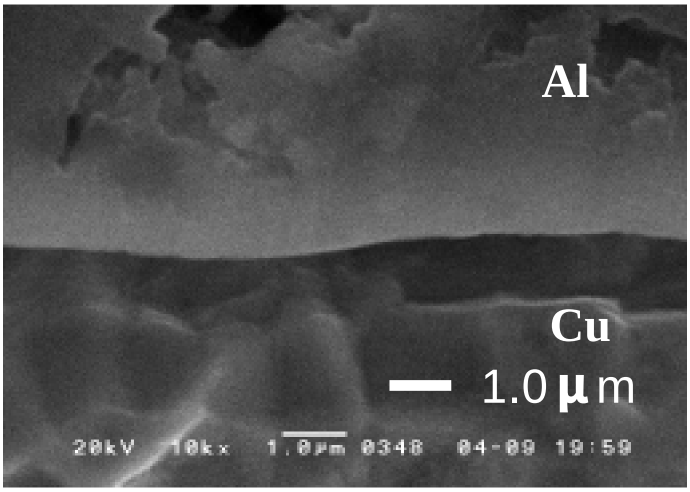

Figure 2: SEM photograph of aluminum and copper specimens welded using the 19 kHz welding system.

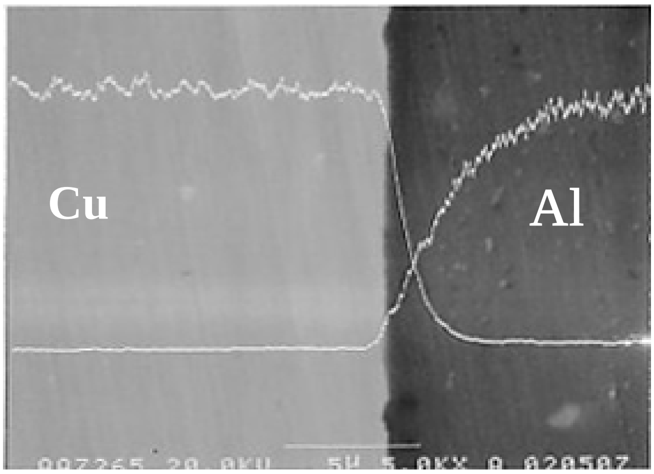

Figure3: The result of Energy dispersive X-ray spectroscopy spectra of aluminum and copper specimens welded using the 19 kHz system.

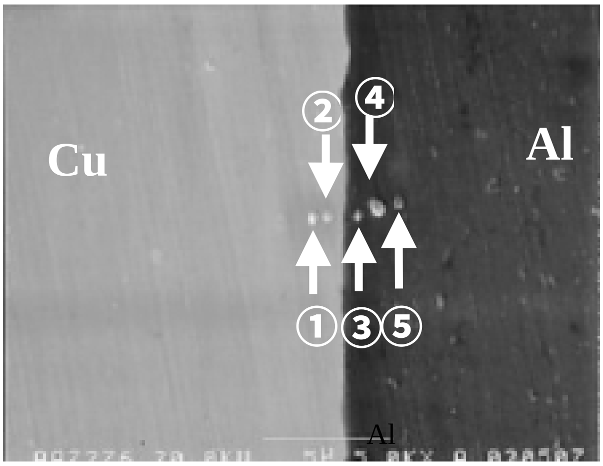

Figure 4: SEM photograph of aluminum and copper specimens welded and measurement points inspected by Energy dispersive X-ray spectroscopy spectra.

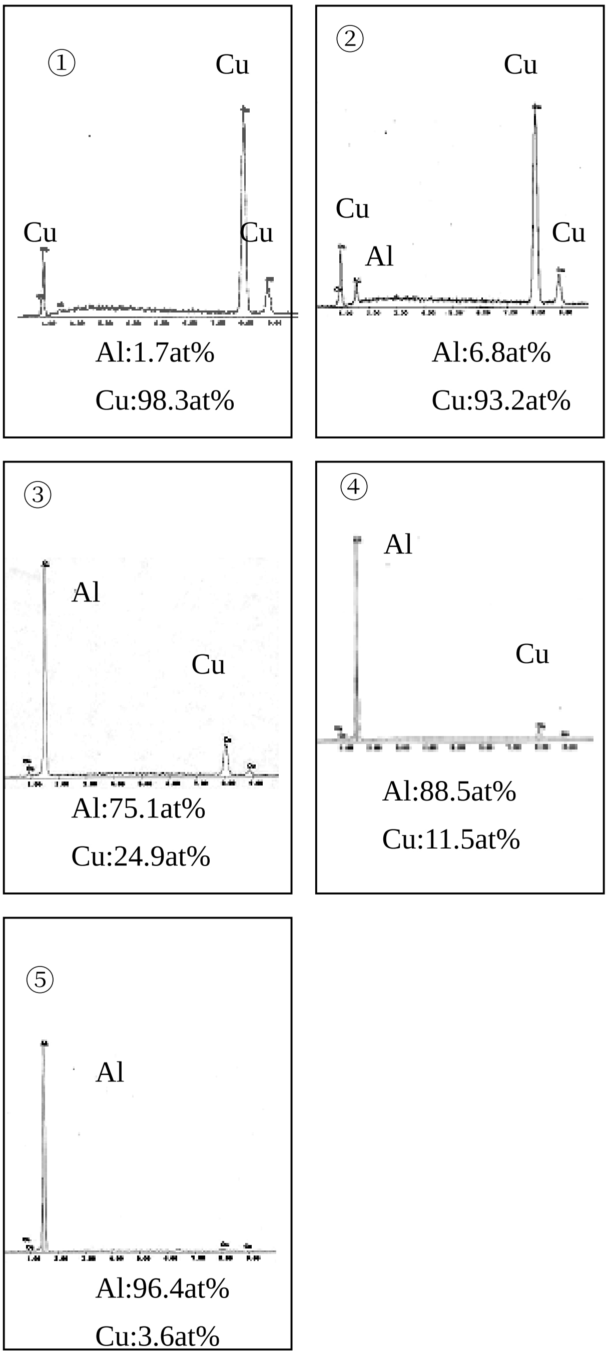

Figure 5: Results of Energy dispersive X-ray spectroscopy spectra of aluminum and copper specimens welded Using the 19 kHz welding equipment.