40 kHz Ultrasonic Complex Vibration Welding System Using Various Exchangeable Welding Tips for Different Welding Specimens

Jiromaru Tsujino[1]
[1]Kanagawa University, LINK-US Co., Ltd, Yokohama, Japan

Background, Motivation and Objective

Ultrasonic complex vibration welding systems using two-dimensional vibration stress were proved significantly superior welding method compared with conventional welding system using linear vibration. 19.5 kHz ultrasonic complex vibration welding using various exchangeable complex vibration welding tip have been probed significantly effective for various electronic devices, Li-ion battery or capacitor electrodes and terminals, and other various industry fields.

To decrease required vibration amplitude and static clamping force, 27 kHz was developed and furthermore 40 kHz complex vibration welding system was designed newly. Required vibration amplitudes for 40 kHz welding system are 34% compared with 19.5 kHz welding system.

Statement of Contribution/Method

40 kHz complex vibration welding system developed was using complex vibration converter with diagonal slits and driven by a longitudinal vibration driving system in one-dimensional configuration (Fig.1). Schematic diagram and longitudinal and torsional vibration distributions between free vibration part of the converter and a nodal part of driving longitudinal vibration horn are shown in Fig. 2.

To secure sufficient working space, 30-mm-diameter complex vibration converter was designed as one-wave longitudinal length mode. Longitudinal vibration distribution is 5/4 wavelength and torsional vibration distribution is 7/4 wavelength along the vibration system between the free edge of the converter and the nodal part of longitudinal driving system. Elliptical to circular vibration locus is obtained in the case the vibration phase difference of longitudinal and torsional vibration at the free edge is near to 90 degrees. Various non-resonant and resonant complex transverse vibration welding tip could be installed in the four parts of the free edge.

Results/ Discussion and Conclusions

The 40 kHz system are driven using 0.6 kW amplifiers and elliptical to circular vibration loci are obtained at the welding tip. Various 10-mm-diameter exchangeable complex vibration welding tips are installed in four positions at the free edge of the converter with a connecting bolt.

Using higher frequency welding system, various specimens including thinner, lighter and smaller welding specimens were welded successfully with smaller vibration amplitude and static clamping force (Fig. 3).

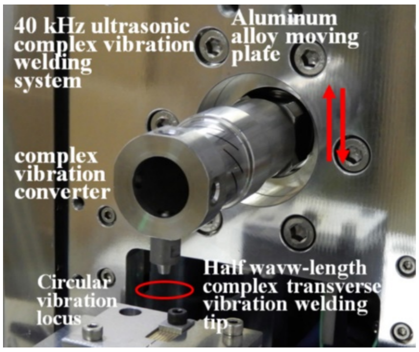

Fig. 1 40 kHz complex vibration welding system istalled in aluminum alloy moving plate with thervo-motor static clamping force and position controll system (1 - 1000 N).

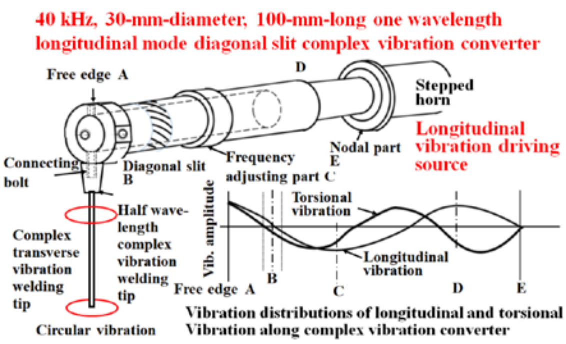

Fig. 2 Schematic diagram of 40 kHz complex vibration system and longitudinal and torsional vibration distributions along the diagonal slit complex vibration converter.

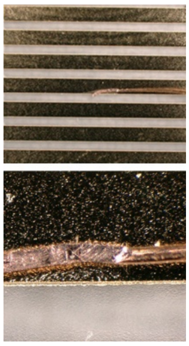

Fig. 3 0.05-mm-diameter copper wire and thin flexible substrate with gold electrode welded using 40 kHz system.