



LINK-US Co., Ltd.
リンクアス

超音波複合振動接合

Ultrasonic COMPLEX Vibration Welding

COMPANY PROFILE

Company Name	LINK-US Co.,Ltd.
Established Date	August 18 th 2014
Capital	JPY771,065,650
CEO	Jun Mitsuyuki
Business description	Development, design, manufacturing and selling of machine for welding similar metals and different metals by Ultrasonic COMPLEX vibration welding
Address	Crescendo Building 5F Office/1F Laboratory, 2-3-4 Shinyokohama, Kouhoku-ku, Yokohama-shi, kanagawa, 222-0033, Japan
History and main sales result	<p>2014年 Established for manufacturing and selling Ultrasonic Complex vibration welding machine</p> <p>2015年 LINK-US first-product as a test machine for the leading Japanese automobile parts manufacturing company was delivered</p> <p>2015年 Capital increased to JPY 25,175,000</p> <p>2016年 Test machine for mass production was delivered to the leading battery manufacture</p> <p>2017年 Mass production machine was delivered to the leading battery manufacture</p> <p>2017年 Test machine for Power device was delivered to the major electrical products manufacture</p> <p>2018年 Capital increased to JPY361,065,650 was invested by INCJ and other investment company</p> <p>2018年 Major battery company started to use for mass production machine in domestic and overseas</p>

Characteristic of Ultrasonic Metal Welding

Ultrasonic metal welding is innovate technology which resolves existing metal welding problems

Existing metal welding problems

Spatter generated

Metal formation change
and alloy generated

Air blow hole generated



Influences

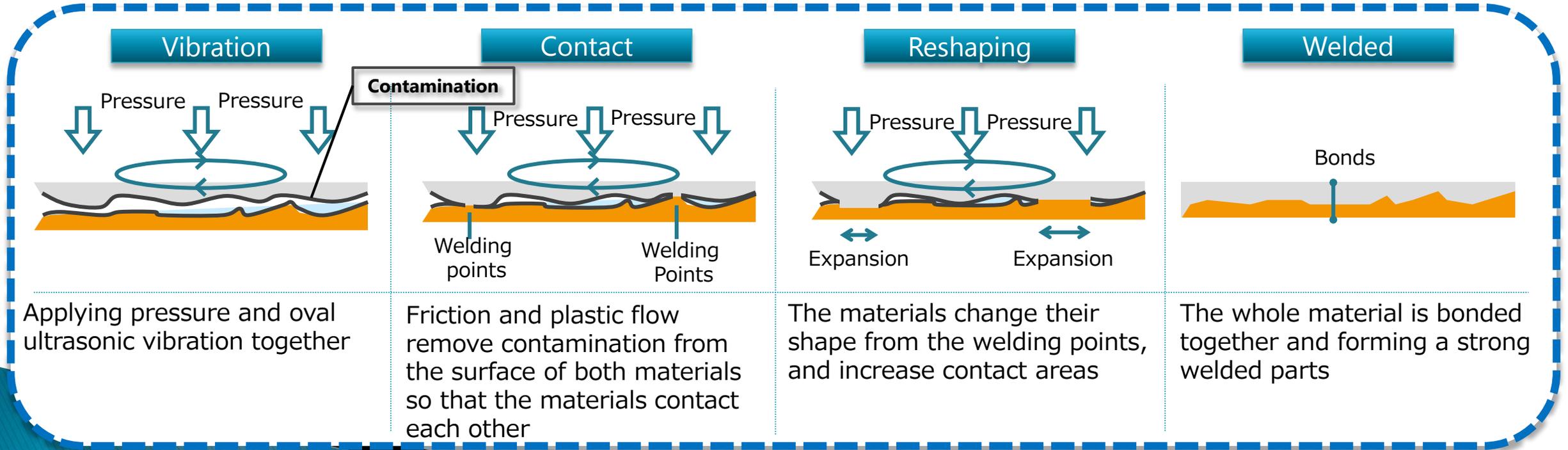
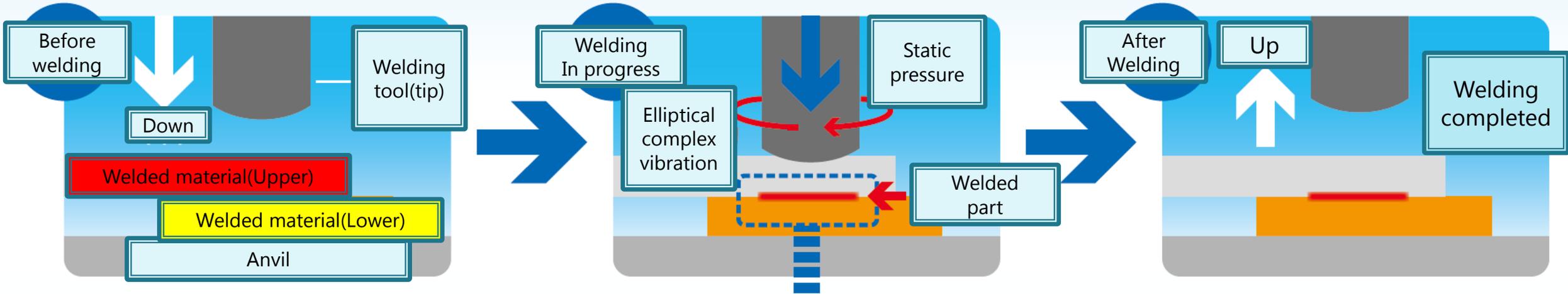
Factor of defect products by contamination

Material characteristic changed
(mechanical and electrical)

Less welding strength
such as aging degradation

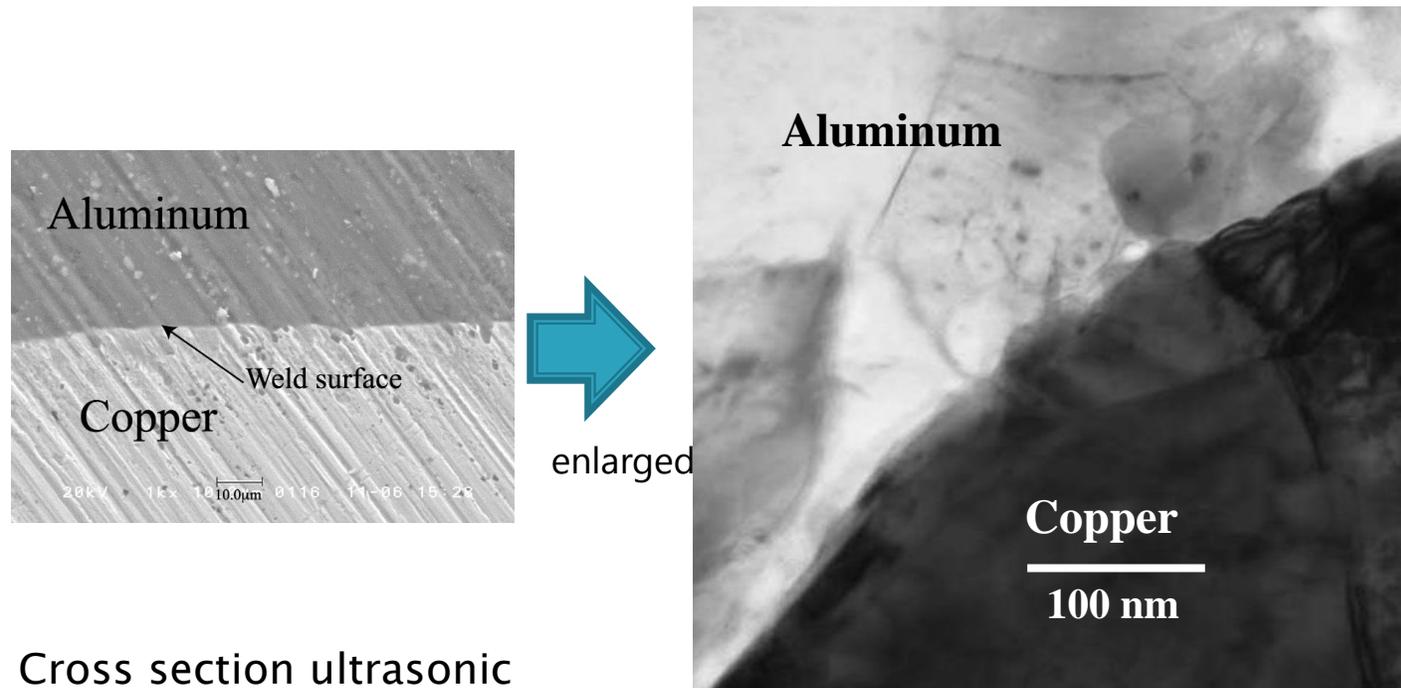
Ultrasonic metal welding technology
resolves above technical problems

Welding Method



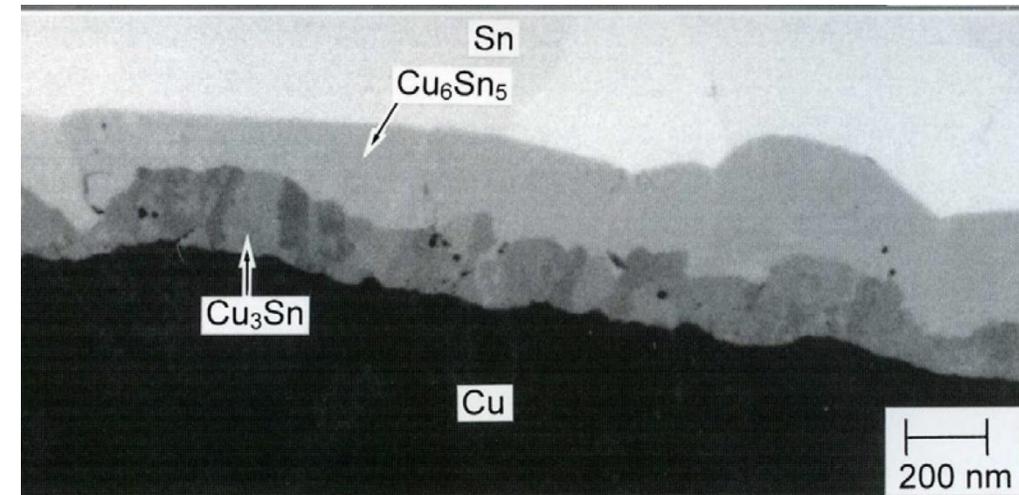
Welded Result

According to observing welded sample in cross section with **ultrasonic COMPLEX vibration**, there is no melting part on the welded surface, no interatomic compounds and no diffuse organization. Due to **interatomic bonded**, there are no melting diffusion change, **no mechanical and electrical characteristic changes**.



Cross section ultrasonic welded area (Al+Cu)

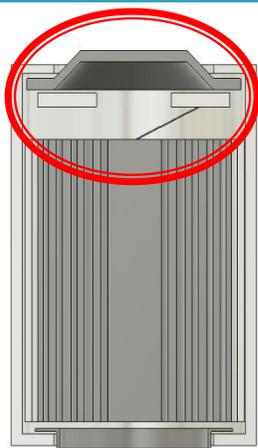
*By TEM photo in Welded sample cross section



In case of general welding, generated alloy layer such the above makes mechanical and electrical changes

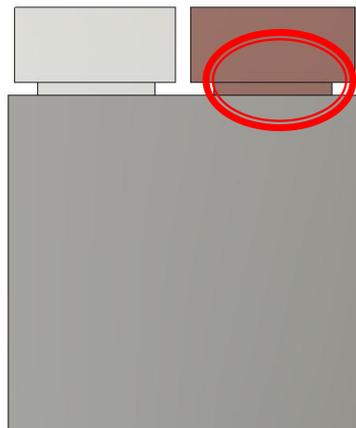
Ultrasonic metal welding application:

Cylindrical type LiB



Collecting foil+Tab

Laminate type LiB



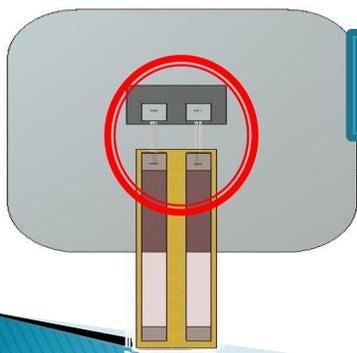
Collecting foil+Tab

Assembling battery



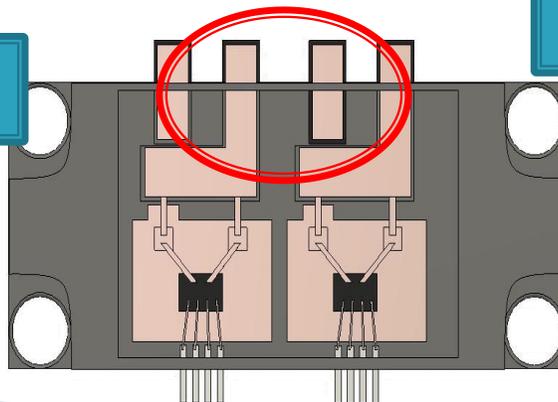
Assembling Battery + Busbar

Flexible circuit board



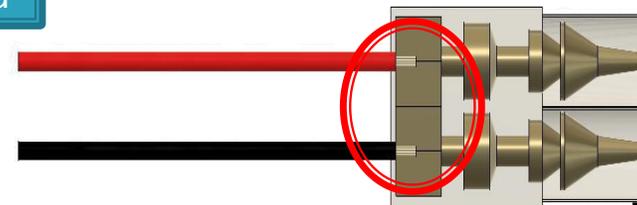
Copper wire + Circuit board

Power device



Copper wire + Circuit board

Connector



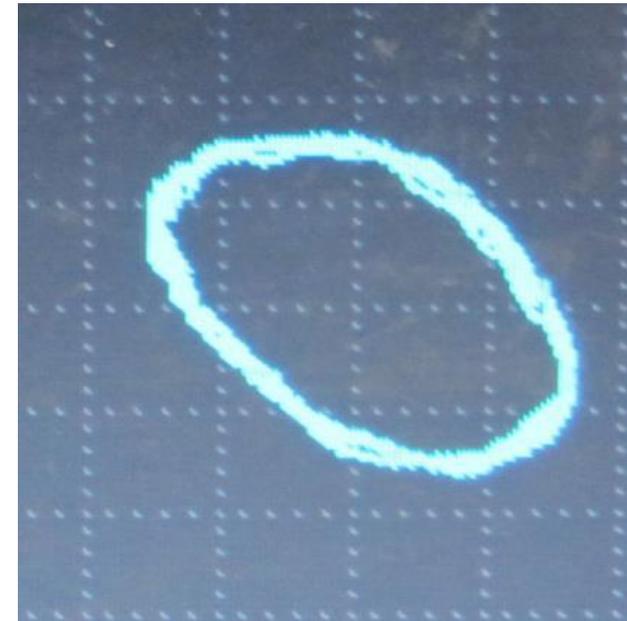
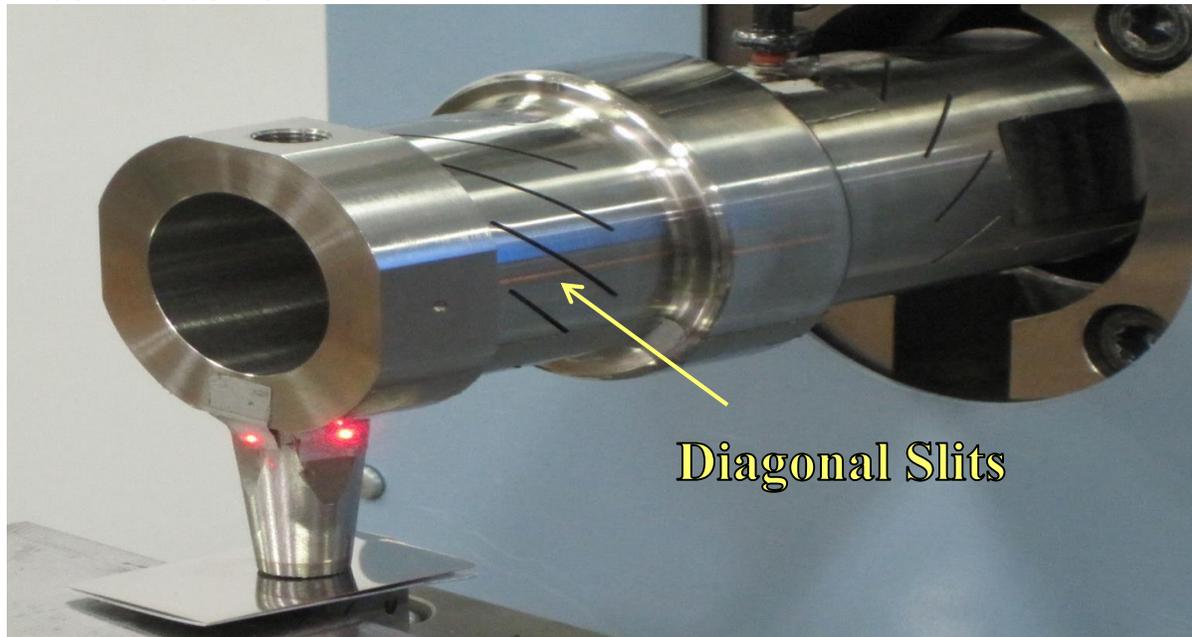
Copper wire + Circuit board

Etc.....

Ultrasonic COMPLEX vibration ?

The world's only one
Patented technology

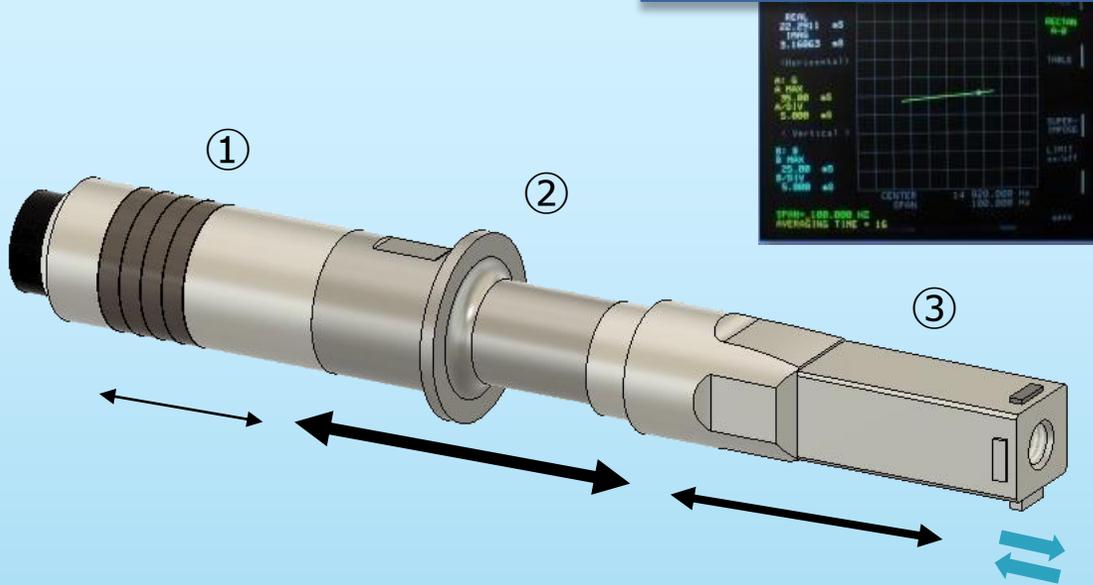
Our COMPLEX vibration(Patented) is the technology generated with circular or elliptical vibration by adding **torsional vibration** to linear vibration. Compare to linear vibration welding, COMPLEX vibration welding needs less energy and gives stronger welding in any direction. Less energy gives less damage onto material!



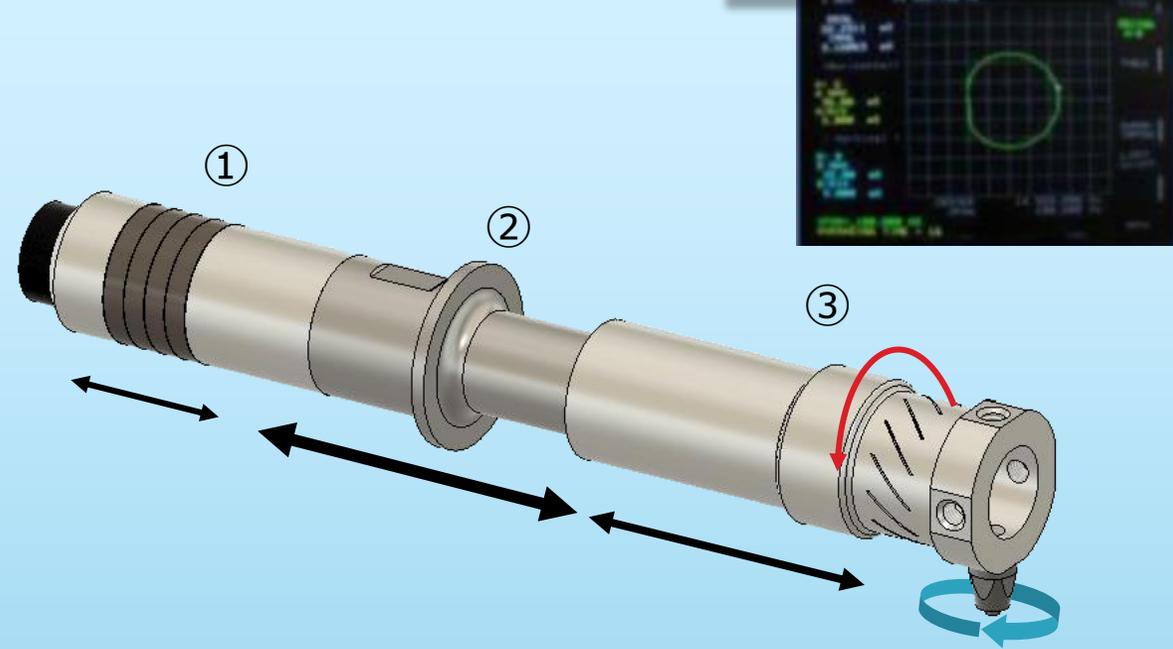
Track of COMPLEX vibration measured with 2 units laser doppler

Mechanism for generating COMPLEX vibration welding

Linear vibration configuration



COMPLEX vibration Configuration



① Longitudinal Ultrasonic vibrator	② Vibration velocity transformer horn	③ Linear vibration welding tip
Ultrasonic Vibration generator	Vibration amplifier	Welding parts

① Longitudinal Ultrasonic vibrator	② Vibration velocity transformer horn	③ Complex vibration converter with diagonal slits
Ultrasonic vibration generator	Vibration amplifier	Complex vibration generator

Merit of COMPLEX vibration

It has 3 advantages to comparing original linear vibration with complex vibration (by adding torsional vibration to Linear vibration)

COMPLEX vibration

More removal of oxide layer



- Welding with less energy
- Reduce damage onto materials

Vibration track with no back and forth



- Welding with less energy
- Reduce damage onto material
- Less Spatter
- Less heat influence to the around welding point
- More strength

Welding with various direction



- By various directional welding, constant and stable strength can be obtained

Small energy welding

To compare welding required energy, trial test will be done in case of the same welding strength

Trail material : Upper material AL (A1050) 100mm×30mm t=1mm
Lower Material AL (A1050) 100mm×30mm t=1mm

■ Linear vibration ultrasonic welding

Frequency : 20 KHz

Amp : 90%

Vibration period :0.3sec.

Welding strength : 1740.0N

Required Energy : 712.9J

■ Link-Us COMPLEX vibration ultrasonic welding

Frequency : 20 KHz

Amp : 80%

Vibration period : 0.2sec.

Welding strength : 1713.4N

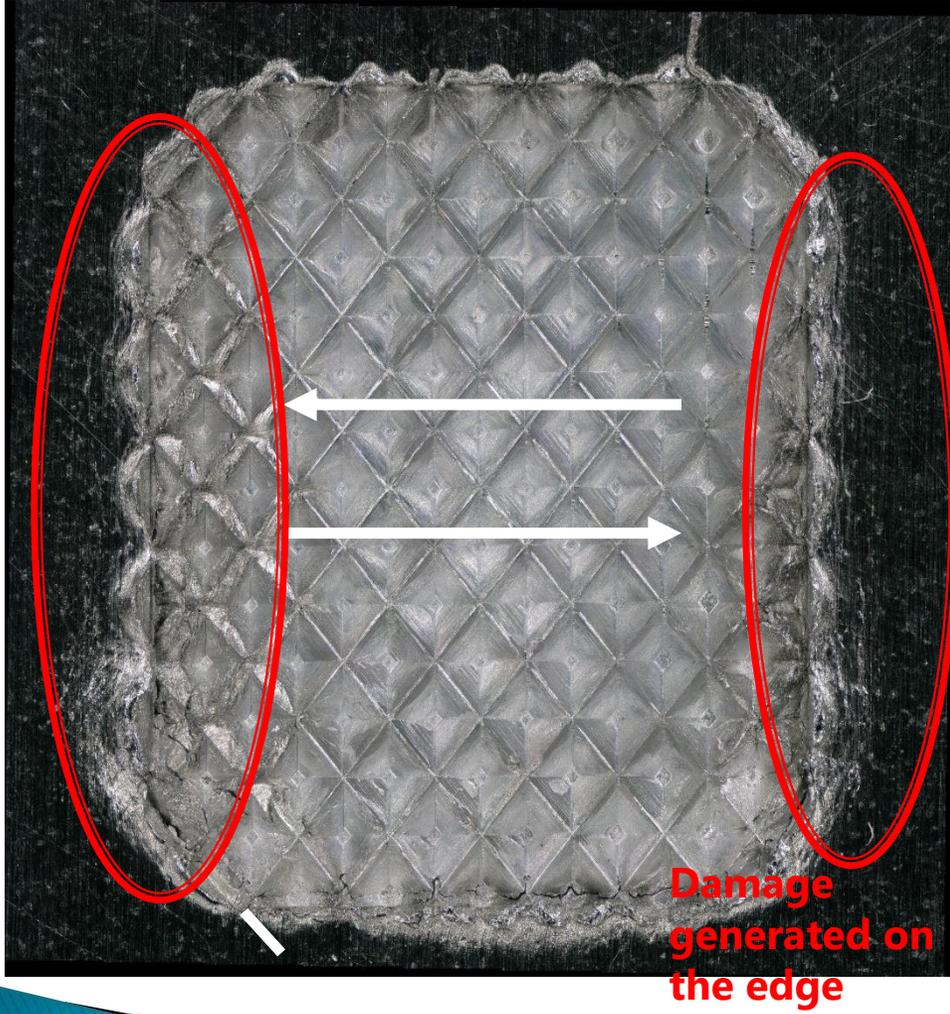
Required energy : 264.2J



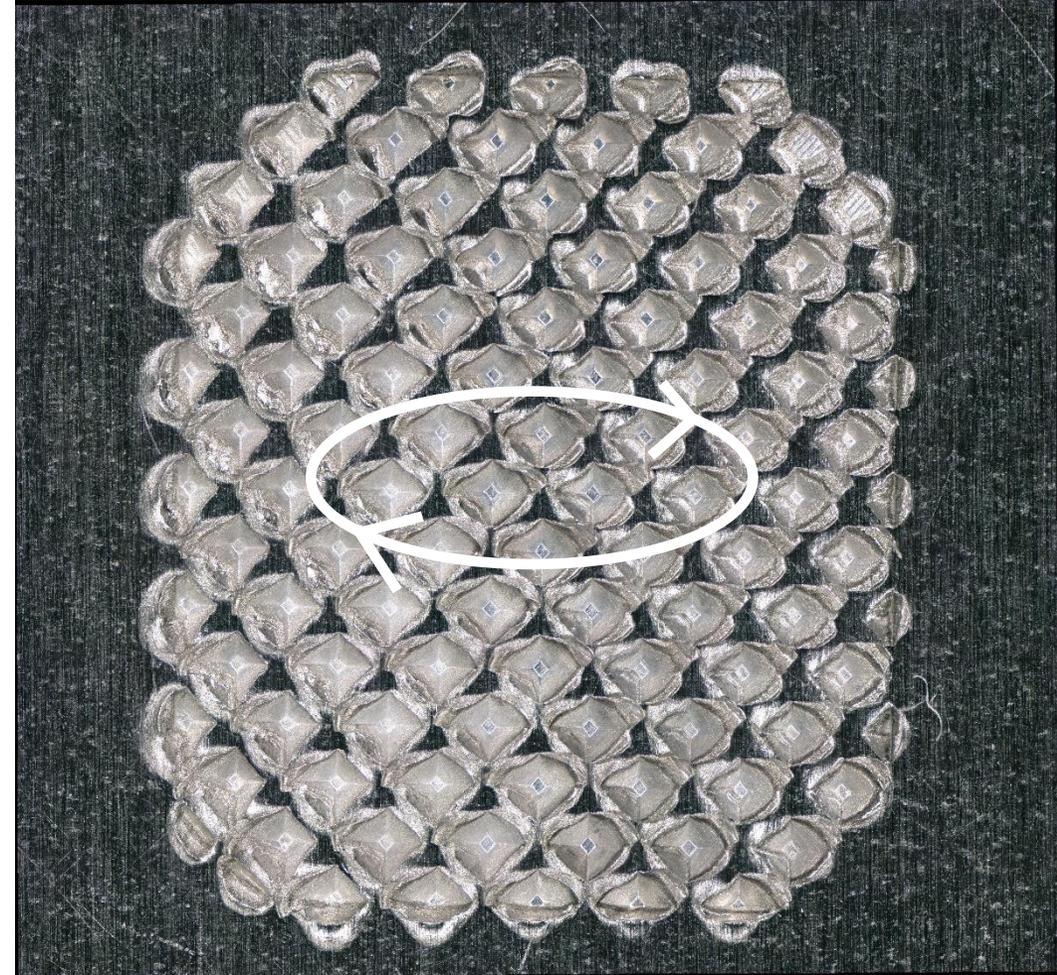
**Comparison to linear vibration,
COMPLEX vibration needs less than
half energy**

Comparison with track of between linear and COMPLEX vibration

Linear vibration



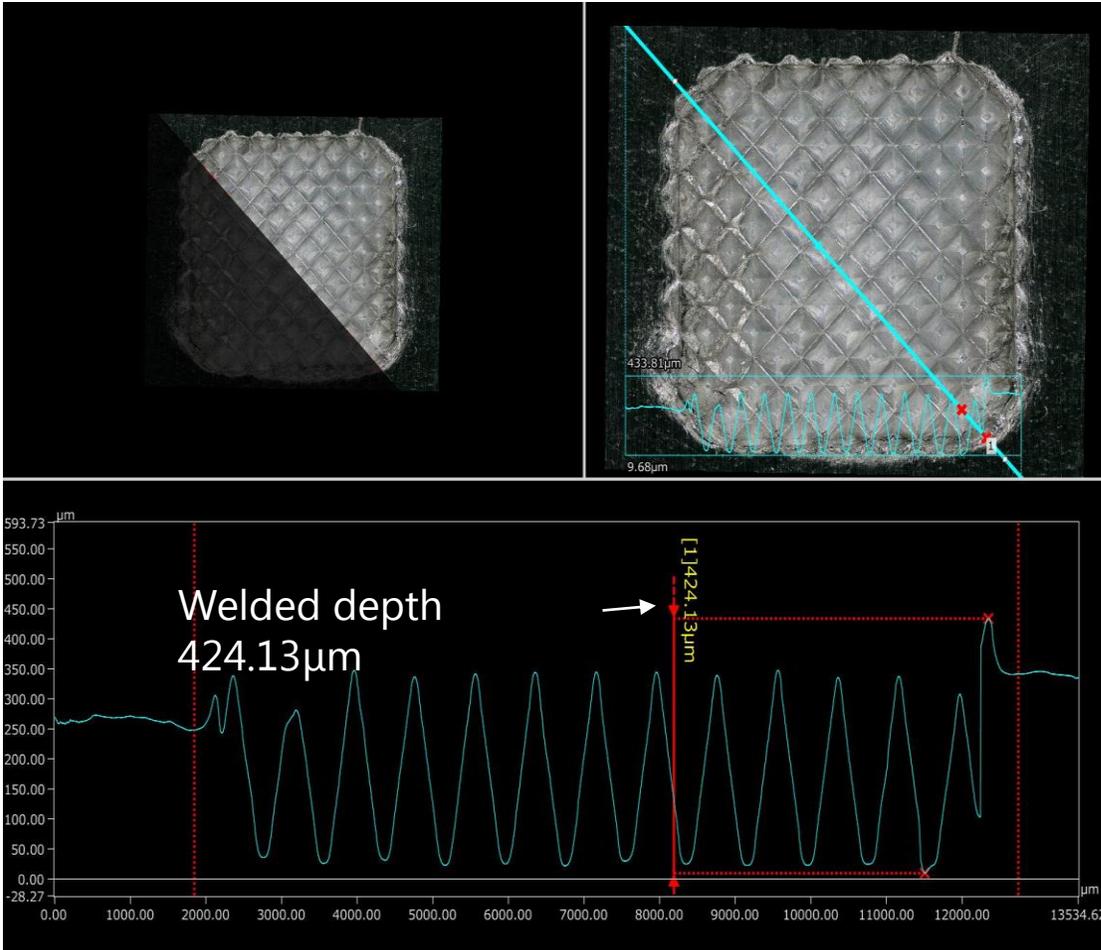
COMPLEX vibration



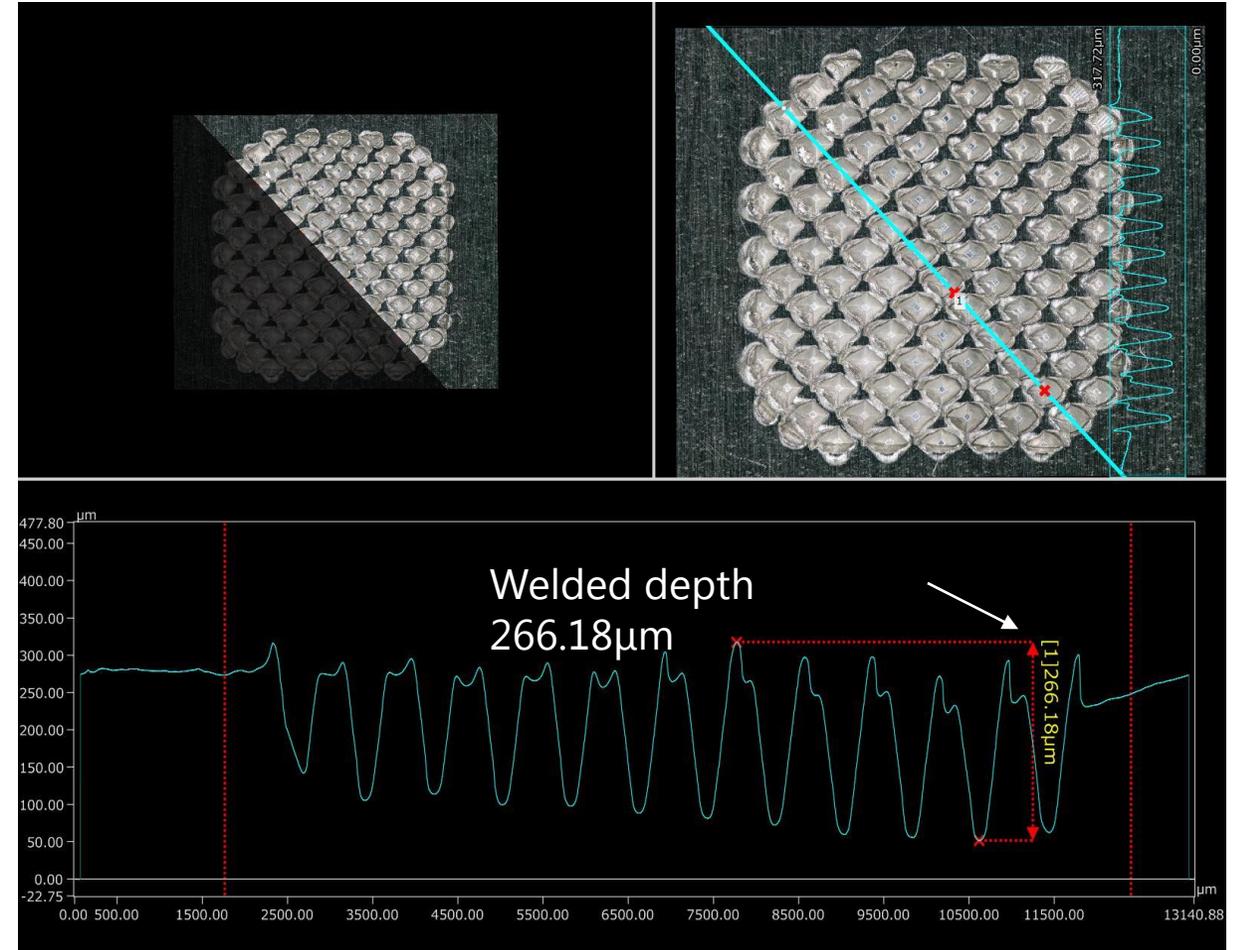
Damage can't be found with
COMPLEX vibration

Comparison with track between Linear vibration and COMPLEX vibration

Linear vibration



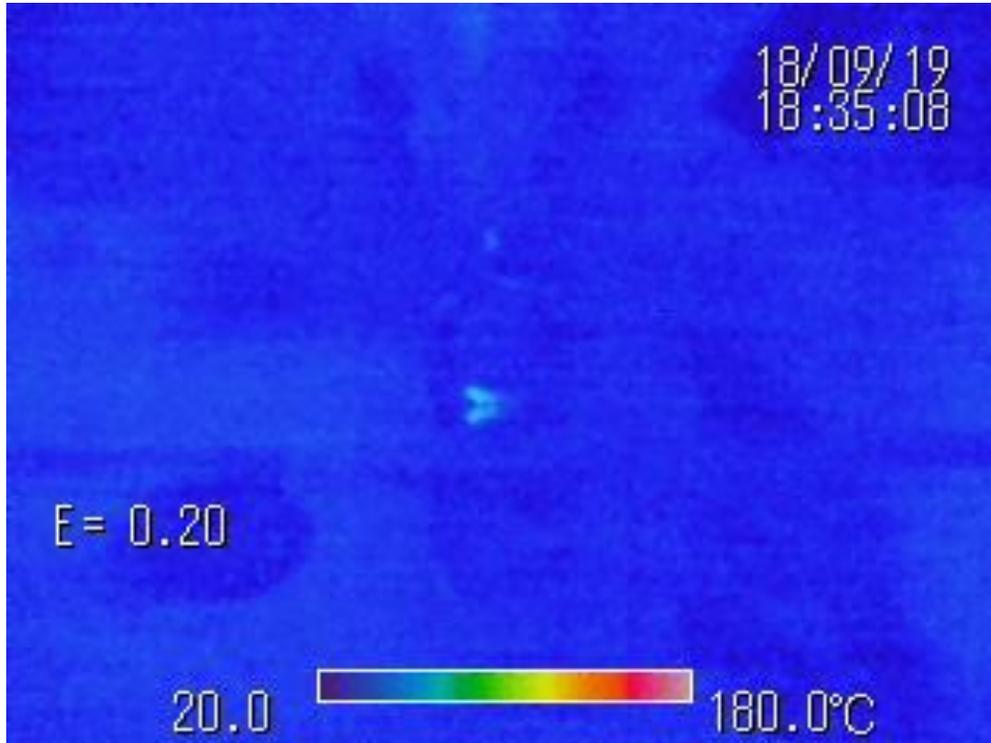
Complex vibration



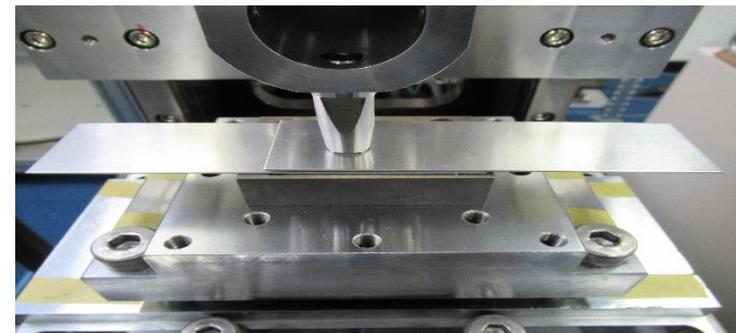
Compare with Linear vibration , COMPLEX vibration is about half welded depth

Comparison with temperature around welding point ①

Linear vibration



COMPLEX vibration



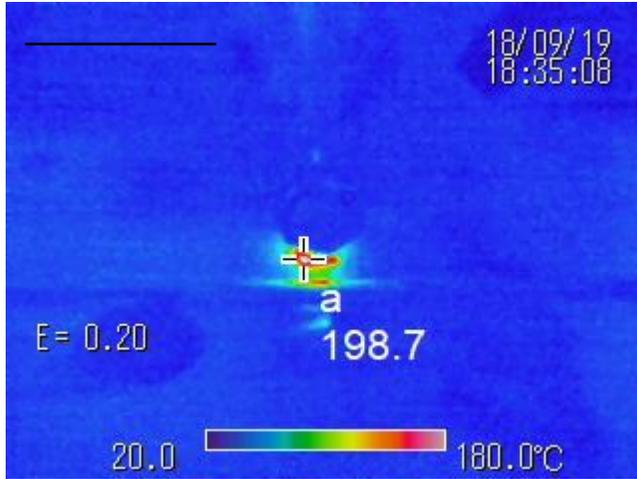
* Thermography Photograph for temperature around welding
(Setting temperature range 0°C~200°C)

Upper Material AL (A1050) 100mm×30mm t=1mm

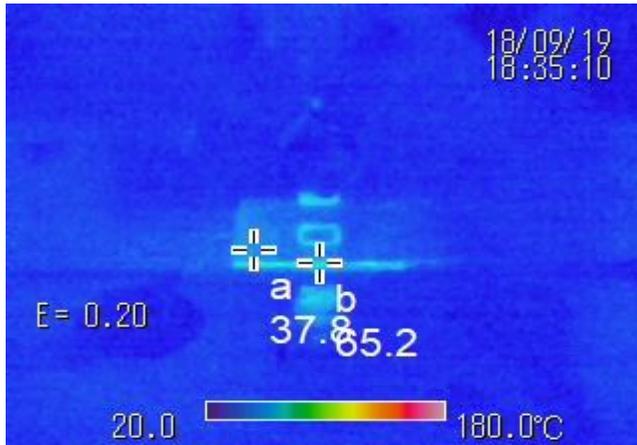
Lower Material AL (A1050) 100mm×30mm t=1mm

Comparison with temperature around welding point ②

Linear vibration

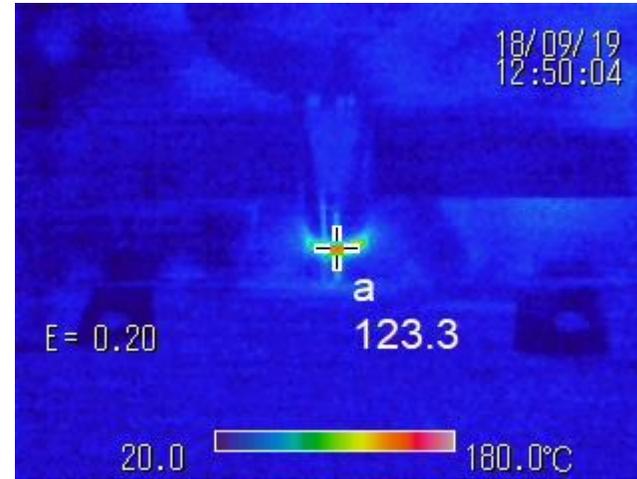


a) Maxim temperature : 198.7°C
* happened 0.4 S after start vibration

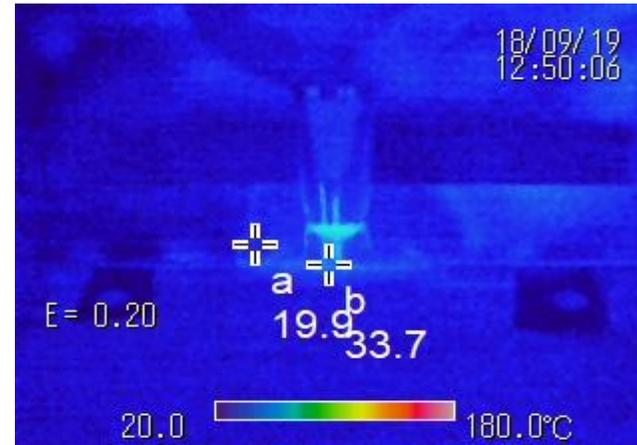


a) Welded point around temperature : 37.8°C
b) After welded sample side temperature : 65.2°C

COMPLEX vibration



a) Maxim temperature : 123.3°C
* happened 0.4sec after start vibration



a) Welded point around temperature : 19.9°C
b) After welded sample side temperature : 33.7°C



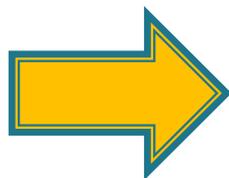
Compare to linear vibration, less temperature influence around welding area

Comparison of temperature increasing at welding face

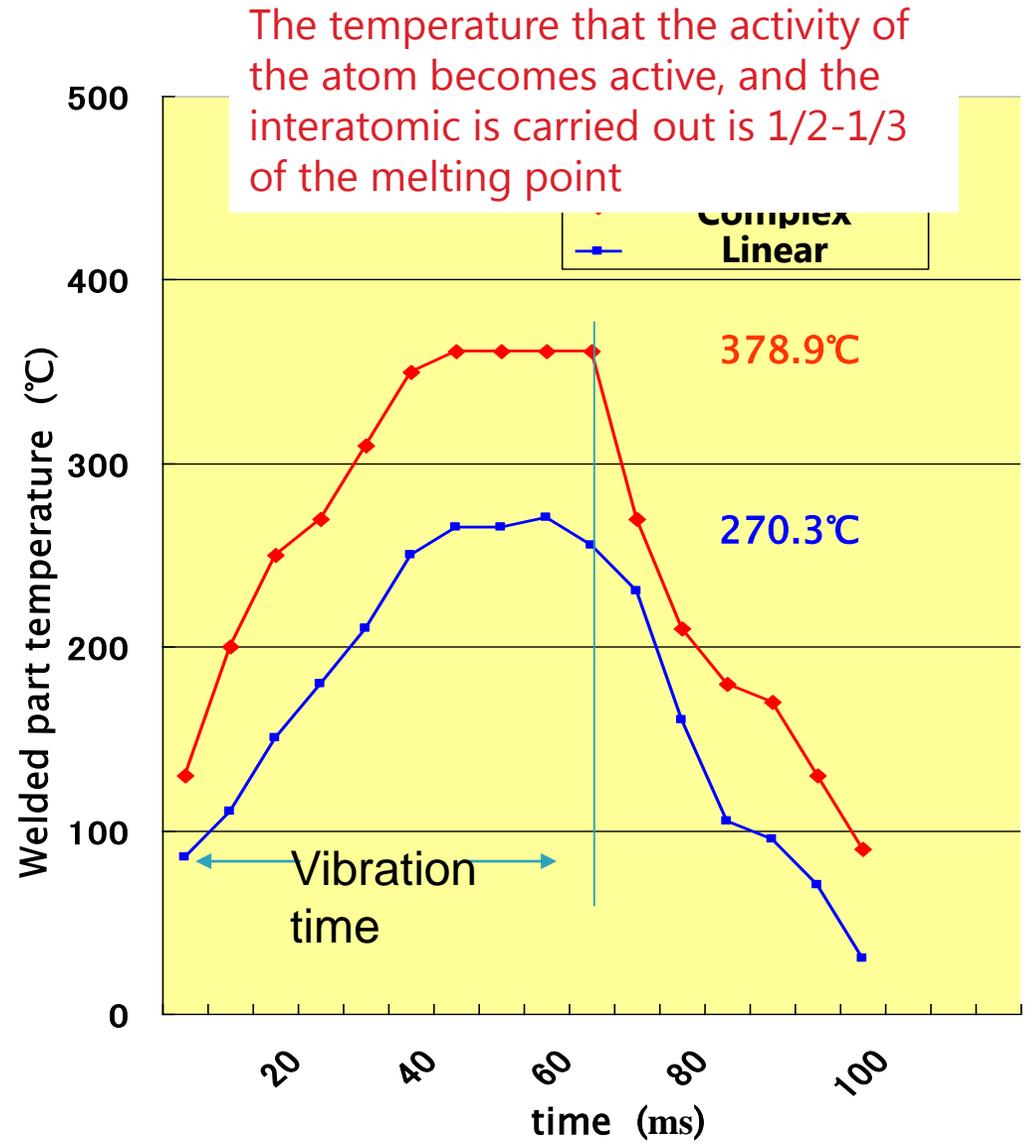
Right graph shows temperature increasing of welding face between $\Phi 0.1\text{mm}$ aluminum thin wire and lead copper chip by applying same static force with Linear and Complex vibration. (Measure with thermo-electromotive force)

As for the welding face of temperature increasing with COMPLEX vibration, it is bigger rising temperature speed and shorter time for reaching high temperature

※Ultrasonic welding can be done faster!

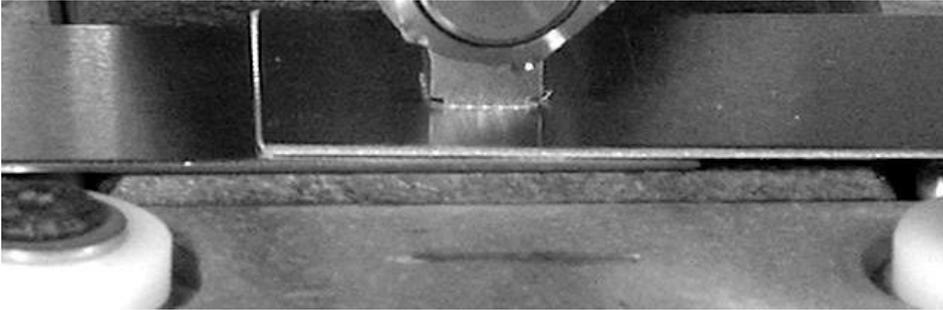


Right graph shows temperature rising speed is about twice higher and max temperature 1.4 times

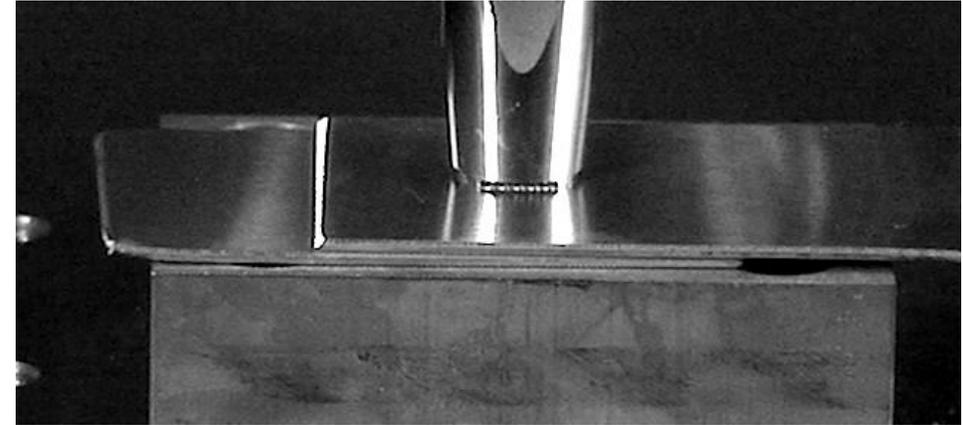


Comparison volume of contamination

Linear vibration (Knurling)



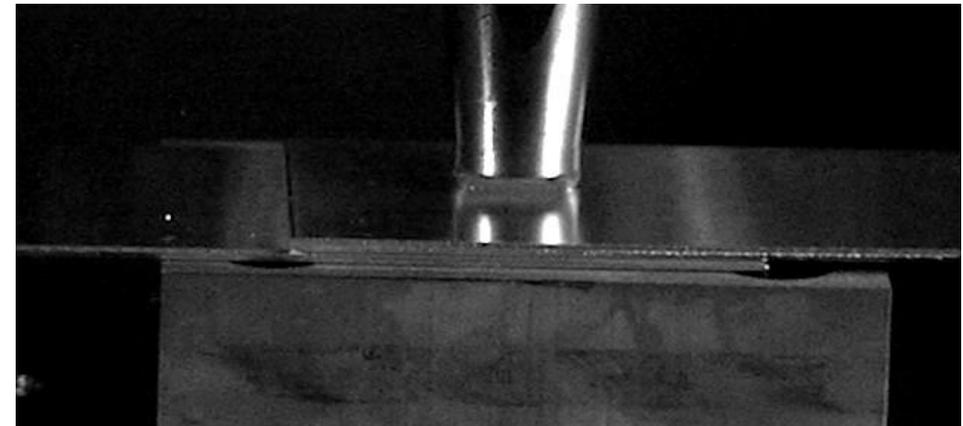
COMPLEX vibration (Knurling)



Result compared between Linear and COMPLEX vibration

- Spatter volume ⇒ COMPLEX vibration generated less spatter
- Welded point burr ⇒ large burr shape isn't found by COMPLEX vibration

COMPLEX vibration (dimple)

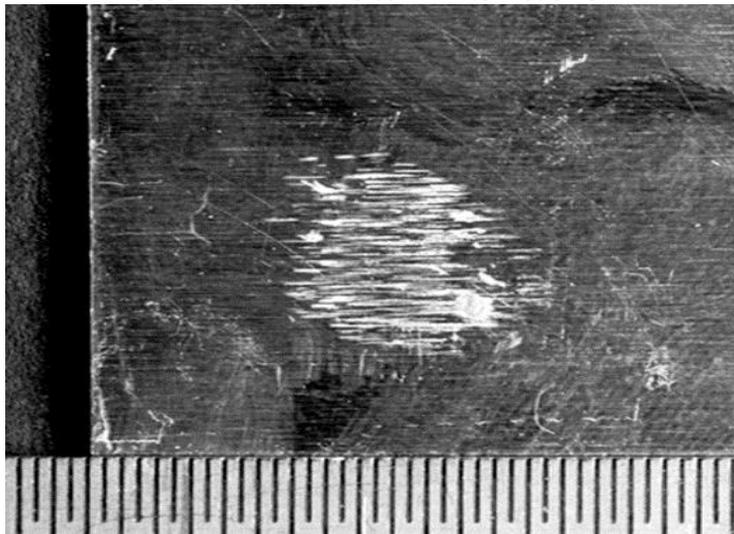


Welding direction

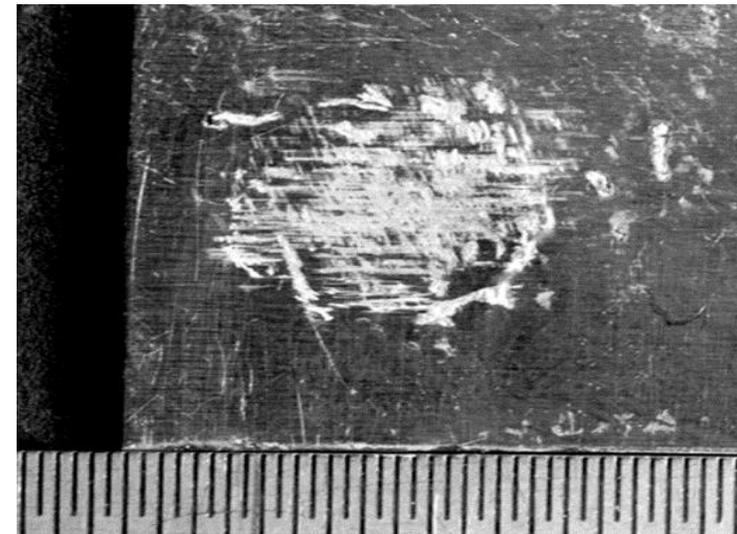
Vibration track of welding tip (Applying COMPLEX vibration stress)

- Adding torsional to the same frequency linear vibration, vibration track of welding tip is changed from original linear shape to circular or elliptical by COMPLEX vibration
- Combine the orthogonal vibration of the different frequency, and make rectangle or square COMPLEX vibration

Track of linear vibration



Track of COMPLEX vibration



Various direction welding gives constant and stable strength

Machine Specification



20kHz Ultrasonic Complex Vibration Welder

Model LT2000-CT1

Machine dimensions and weight

Main devices Drive part 365 (W) × 686 (D) × 1138 (H) mm approx.
Vibrator 370 (W) × 450 (D) × 205 (H) mm approx.
Control panel 800 (W) × 400 (D) × 750 (H) mm approx.

Weight Drive part :160kg approx. Control panel :100 kg approx.
Vibrator:20kg approx.

Welding specifications

Frequency 20kHz (19.5kHz±5%) **Welding area** 78.5mm² *1

Drive system AC servo motor (2kW)

Pressure control Position control, contact pressure control, and speed control by AC servo motor
Setting range: 1 to 2000 N*2

Workpiece Workpiece specified by the user*1

Max. stroke Distance between the horn standby position and the max. subduction position:
80 mm max. (during normal operation) *1

40kHz Ultrasonic Complex Vibration Welder

Model LT1000-40k

Machine dimensions and weight

Main devices Drive part: 280 (W) × 500 (D) × 751 (H) mm
Stand: 750 (W) × 700 (D) × 1676 (H) mm

Weight Gross weight: 270 kg approx.
(Drive part 45 kg, control panel 100 kg, vibrator 20 kg approx.)

Welding specifications

Frequency 40kHz (39±1kHz) **Welding area** 78.5mm² (φ10)*1

Drive system AC servo motor (1kW)

Pressure control Setting range: 1 to 1000N*2

Workpiece Workpiece specified by the user*1

Max. stroke Distance between the horn home position and the anvil: 50 mm (during maintenance)
Distance between the horn standby position and the max. subduction position:
40 mm max. (during normal operation)*1

The shape of tool can be ordered as custom-made!