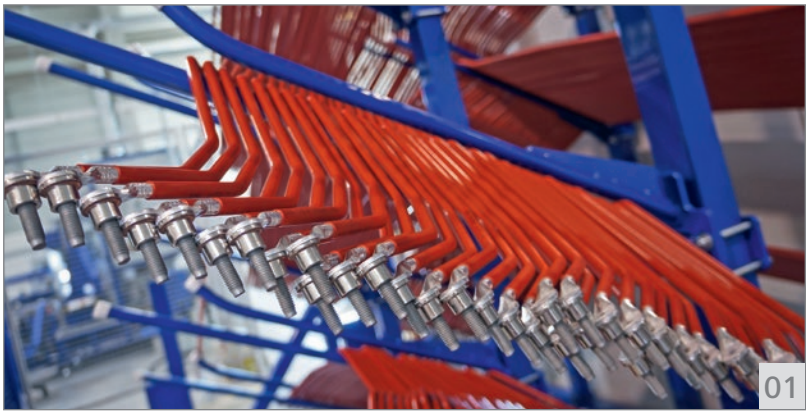
TELSONIC
ULTRASONICS

Securely contacting aluminium

Torsional ultrasonic welding technology in use

PLASTIC WELDING | METAL WELDING | CUTTING | CLEANING | SCREENING


01


02

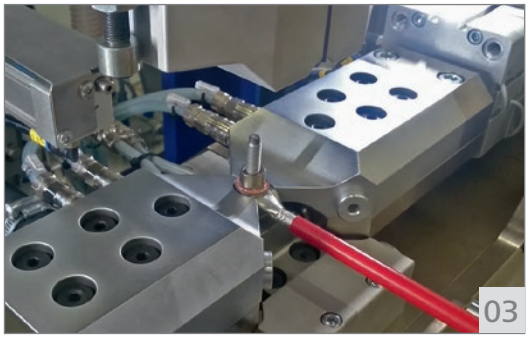
Bronschhofen (CH), 02/2018

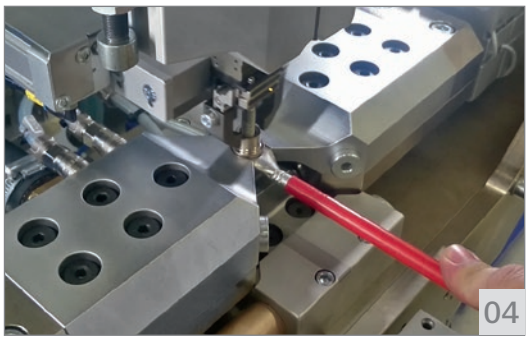
Lightweight construction is an important trend in the automotive industry. As well as cutting down on weight – e.g. through the use of aluminium – it enables significant cost savings. As constructors and users are ever less ready to accept compromises in material quality in favour of traditional joining technologies, however, traditional welding and adhesive processes are increasingly reaching their limits, especially when it comes to joining different types of metal. For this reason, torsional ultrasonic welding technology, often also known as high-frequency friction welding, is asserting itself as a joining technology of the future, especially in lightweight construction. A typical application is the manufacture of so-called aluminium busbars for the power supply in the engine compartment of modern vehicles.

To save on weight and costs, the energy distribution in automobiles is increasingly being switched to aluminium conductors. The potential for savings is especially large if the battery – for the sake of a balanced weight distribution – is housed in the back of the vehicle. However, the battery must then connect with the components in the engine compartment over a relatively long distance. Traditional cables are usually no longer the preferred choice for this. Ten years ago the trend was already towards rigid flat cables made from aluminium, which are lighter and easier to install. But development has continued. Today it is ever more common to use round aluminium cables for the secure power supply of the battery in the engine compartment, and for good reason: they are easier to manufacture and can be easily adapted to different vehicle shapes because they can be bent easily (Figure 1).

Round aluminium power rail instead of non-rigid copper cable

An aluminium power rail has some advantages compared to copper cables. For example, the massive aluminium conductor can be shaped in three dimensions and weighs only around half of the traditional copper components. In absolute terms, the savings in battery weight can therefore amount to several


03


04

01 Aluminium conductor assembled on the corresponding vehicle

02 Connecting bolts welded with torsional ultrasonic technology

03/04 Torsional ultrasonic welding system in portal design. The threaded bolts are supplied via pick and place and welded with the aluminium busbar.

kilograms in the battery connection alone. Compared to a multi-wired copper cable with a diameter of 15.5 mm, the aluminium rail, with identical conductivity, has a diameter of only around 14 mm, which takes the ever tighter construction space in modern vehicles into account.
The round aluminium busbars are manufactured from a thermoplastically insulated blank and bent in three dimensions for adaptation to the specific vehicle type. It is much easier to handle this rigid busbar than a non-rigid cable. This benefits the automotive manufacturer during installation. With a few handgrips the component can be fastened to corresponding clips on the vehicle floor.

Secure contacting in the engine compartment

To ensure the contact in the engine compartment is secure, on the front end of the busbar an approximately 30 mm long connecting bolt with a screw thread (Figure 2) is welded on to the aluminium. Previously, this bolt was pressed into a copper-nickel sleeve that can be joined more easily to the aluminium. Thanks to the nickel-plating of the contacting base, the corrosion risk for the aluminium is negligible. At the same time the weld is significantly stronger than a copper-aluminium connection. Thanks to the Soniqtwist torsional ultrasonic welding process developed by Telsonic, the bolt and the aluminium power rail can then be quickly and securely connected with one another (Figures 3 and 4):
Via pick and place the supplied bolts are taken from a magazine and precisely positioned on the busbar beneath the sonotrode for the welding process. For high repeat precision and to ensure quality under high load, the anvil is water-cooled. The welding process then lasts only around one second, which allows the aluminium busbars to be produced in large numbers in a short time. Currently the values are around 700,000 parts per year per system.

Ultra-tight welding connections

The torsional welding process is based on the long-established linear metal welding process for copper, aluminium, nickel, bronze, brass and other mixed combinations. The Swiss ultrasonic experts have developed this conventional ultrasonic welding technology further, doing pioneering work especially in connection with the manufacture of aluminium busbars:
In ultrasonic welding, an acoustically designed tool transmits high-frequency vibrations. These high-frequency, mechanical vibrations set the top joining element vibrating, while the lower joining element is prevented by the counter-tool («anvil») from vibrating along with it. This generates heat which breaks open the material limits, that is the oxide layers, and welds the joining partner elements together in this way. This is called diffusion welding. During the torsional welding process, the sonotrode is now stimulated by a torsional resonator and as a result twists alternately right and left at a high frequency of up to 40 µm. This «twisting» can bring very large force and power to bear on the welding surface, allowing even thicker workpieces to be joined very firmly. The welding points are significantly more highly compressed and therefore even firmer than with traditional ultrasonic welding.
But the torsional ultrasonic welding technology not only generates ultra-tight connections with high electrical conductivity within a very short time; it is also environmentally-friendly, as there are no additives such as adhesive, solder or other consumables. The process is reliable and secure as the welding process can be configured using just a few parameters and can be monitored easily. The ultrasonic generator with a power of 10 kW works at a frequency of 20 kHz. With its touchscreen operation and clear structure, the menu-driven software enables efficient set-up and work. The prescribed quality control simplifies quality tolerance windows, which are set for all welding results in set-up mode. Upper and lower threshold values can be set for welding time as well as maximum output. An alarm is triggered if these values are exceeded or under run. Statistical evaluations, automatic calibration, maintenance menu for maintenance work, reference mode and an ultrasonic test mode extend its functions. This flexibility allows bolts to be welded to any busbars for completely different vehicle types; in the process, individual manufacture down to batch size 1 is no problem.

by Thomas Hünig, Technical Director at Telsonic GmbH, Erlangen, and Ellen-Christine Reiff, Redaktionsbüro Stutensee