Stirtec welds materials, which cannot be joined by conventional welding processes

"Welding the Unweldable" is the slogan of Stirtec in Austria

The engineers at Stirtec use Friction Stir Welding (FSW) even for material combinations that can otherwise only be joined with exceptional efforts, for instance steel sheets to aluminium extrusions or castings. They produce battery housings and bimetal bus bars for electric vehicles and weld copper to steel or to aluminium for heat sinks. They provide contract manufacturing services in low-volume production, during production ramp-up or to address unforeseen production peaks. For high-volume production they offer FSW machines and customer-specific manufacturing cells. They are a turnkey partner from the concept development until serial production and offer the complete FSW package from one source.

Friction stir welding

Friction stir welding (FSW) is being used worldwide since the 1990s. On the first sight, it appears to be as simple as running a milling machine, but on closer examination special machines and in-depth know-how are required, to use the process industrially.

FSW operates in the solid phase without melting. The rotating tool generates heat, plasticises the workpiece material, stirs-up the oxides and forges the material under high forces into the joint line. Therefore, it is similar to forging and improves the microstructure of the workpieces underneath the rotating tool. The vertical welding and milling centre V-WMC2080, which is shown above, can press the tool with forces of up to 25kN (2,5t) onto the workpiece.

Friction stir welding tools

The wear resistant tool looks similar to a milling cutter. It has a probe with a complex profile and a shoulder, which has a larger diameter than the probe. The probe, which is plunged into the workpieces, is nearly as long as the sheet thickness.

Sheets of 0.5mm and above can be welded. At the upper level, up to 70mm thick aluminium plates can be welded in one layer. Significant cost reductions can be achieved, because weld preparation and time consuming multilayer welds are from now on obsolete.

If absolutely leak-tight welds are required, the probe may be controlled separately and retracted into the shoulder to avoid an end hole. Alternatively, the tool may be moved sideward, to position the end hole outside of the weld centre line. In both cases helium tight welds can be achieved

Weldable materials

Principally, all materials, which can be plasticised, can be friction stir welded, for instance aluminium, steels, copper, titanium, magnesium and their alloys. It is even possible to join polymers to polymers or to metal.

Stirtec takes a leading role particularly for welding of dissimilar metals. As an upcoming trend, steel strips can be welded to both edges of aluminium sheets from a coil. These tailor welded blanks can be stamped into car body panels and then be welded by conventional resistance spot welding robots in the automotive body-in-white production. The concept is being dubbed as Lightweight Material Mix 2.0, as it combines the benefits of lightweight aluminium alloys and weldability to conventional automotive steel structures.

Structural parts from aluminium castings or extrusions, like side intrusion beams or longitudinal crash absorption members can be friction stir welded to steel brackets of various grades. These developments are not only driven by the weight and production cost, but they save also additional investments down the line, because conventional resistance spot welding robots can be used for welding these bimetal parts into steel car bodies.

Friction stir welding of dissimilar metals: copper to steel

Dissimilar metals like copper to steel can be products by FSW without generating brittle intermetallic phases, because the process operates below the melting point of the workpiece materials. Tensile tests demonstrate that the welds so strong that the parts fail in the softer material beside the weld, i.e. in the copper part.

Process Benefits

- High weld seam strength
- Improved microstructure and fatigue strength e.g. by Friction Stir Processing (FSP)
- Reduced risk for cracking and/or avoids the emergence of porosities
- Low distortion and residual stresses
- Easy to automate and monitor (quality assurance)
- Very high degree of reproducibility
- No filler material or welding consumable required
- No smoke, welding spatter or other emissions
- Environment-friendly fabrication process

Benefits of FSW

No weld preparation is required, because the process can cope with tolerances of several tenths of a millimetre, which leads to major cost savings. Due to the low heat input, FSW generates only 10% of the distortion of conventional welding processes.

Butt or overlap joints can be produced without the need for filler material. Friction stir welding is a very cost effective and environmentally friendly process without shielding gas, without fume, without spatter, without UV radiation, without ozone, without powder, without vacuum and without any expensive safety devices.

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Technology and machines

Hybrid FSW CNC machine center V-WMC2080

Stirtec offers very rigid hybrid FSW CNC machine centers with spindles that have been specially specified, developed and proven for the high processing forces of FSW. All FSW machines of the V-WMC series can be used with an automatic tool changing system both for friction stir welding and high-speed machining at up to 15.000rpm

During welding, the tool will be positioned with a closed-loop force and position control system, which has been developed by Stirtec. A parameter monitoring system with an integrated data processing algorithm is optionally available for quality management.

Stirtec provides customers with concepts for complete FSW manufacturing cells including material handling systems by robots. Experienced employees from Stirtec and its partner companies from various industrial sectors are available for undertaking projects under Stirtec's direction and management.

Friction stir spot welding gun D-SWG

Friction Stir Spot Welding (FSSW) is according to ISO/DIS 18785 a variant of FSW, especially if adhesives or sealants have to be applied between the overlapping workpieces. FSSW is currently the most attractive alternative mechanical joining processes for joining steel to aluminium.

Stirtec has developed FSSW systems and solutions in close collaboration with the automotive and transport industry, for instance the new FSSW guns of the D-SWG range, which can be used either with robots or in stationary installations.

The high-performance Friction Stir Spot Welding Gun SWG-D is a powerful and lightweight tool, which can be handled by a robot or integrated into a machining centre. By using the very latest FSSW technology combined with a high-tech force measuring system, this gun offers new possibilities in sheet metal spot welding. Even dissimilar metals such as aluminium to steel can be easily welded. Optionally, automatic tool changing systems are available.

MaXstir tool range

Stirtec's innovative MaXstir tool range is based on many man-years of research and development in the areas of process and materials technology. All of the MaXstir tools are characterized by high functionality, process reliability and exceptional wear resistance, which results in a long service life.

Specific probe profiles are available for FSW in the butt or overlap configuration. The tools can be made either from one piece, or more commonly from two pieces with a fixed or adjustable probe. Stirtec's bobbin tools have a profiled probe between two profiled shoulders for self-reacting the forces during welding.

Moreover, the MaXstir tools also enable comparatively higher welding speeds for the respective application areas. A broad range of material combinations can be welded using MaXstir tools, such as aluminium to aluminium (including high-strength alloys) or different metals, such as steel to aluminium, copper, magnesium or titanium.

Friction Stir Processing (FSP) is for instance used for aluminium castings to consolidate porosity and cavities prior to machining the sealing faces. In addition to that, the company can produce precision machined parts with their CNC lathe or supply laser sintered prototypes via their supply chain.

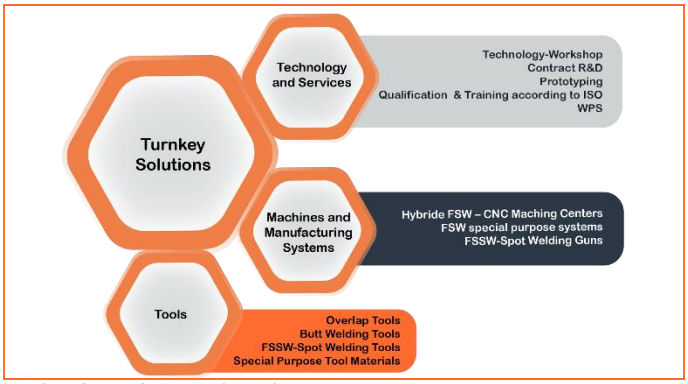
The company

The Stirtec company was founded mid-May 2013 – and before then the technology had been developed by the founders since 2006 mainly in collaboration with the TU Graz (Graz University of Technology).

The founders Dr. Thomas Weinberger and DI Gunter Figner focussed initially on technical consultancy, feasibility studies and prototyping. They have also successfully applied for several patents. Apart from the industrialisation of the FSW technology they focus on developing and manufacturing of advanced tool materials for FSW of high-strength steels.

The manufacture, installation and commissioning of FSW machines became the most important business activity of Stirtec based on the success in conducting industrial projects and due to the increasing industrial interest in implementing FSW in medium and high volume production. The company performance figures develop very dynamically since the set-up of the company.

Turnkey solutions



Stirtec's products and services

Stirtec provides turnkey solutions including materials handling systems for high-volume production.

A project starts typically with a meeting or a workshop, in which the product specific demands will be discussed with the development team and production engineers of the customer. Stirtec offers then in its new manufacturing hall 5 min off Graz Airport application development and customer specific prototyping. Subsequently a WPS (Welding Procedure Specification) will be established according to EN ISO 25239, which is the base for training of the machine setters and operators of the customer.

The parts for prototype assemblies can be supplied by Stirtec as part of the contract manufacturing services, beginning from purchasing raw materials and machining up to post weld processes such as deburring, anodising or painting. The customer gets finally the complete prototype components. If required, quality assessment methods will be applied, such as metallography, tensile or bend tests.

When customers order their machines, they can get the complete package including fixtures and materials handling systems from one hand (technology + machine + tools), which makes your purchase easier and more save.

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