

CMT Additive Pro enhances Fronius' additive manufacturing capability

Wire-based additive manufacturing is an arc-based 3D printing method that builds-up a component in layers of weld metal, allowing for a high degree of flexibility in component geometry. The new CMT Pro Additive from Fronius fulfils the key quality requirements of components produced using this additive process.

Additive production methods, also known as 3D printing, generate components by building up material layer by layer. Wire-based additive manufacturing, which is based on the arc welding process, produces metal parts using this layer by layer process, with the layers formed by melting a wire with a welding arc.

This generative manufacturing method is particularly advantageous when complex component geometries have to be produced, as the design options are virtually limitless. Parts can be manufactured at low cost and extremely quickly, which makes this process a very attractive option for prototype construction and/or small production batches. Comparative processing time, tool wear and material loss for conventional machining processes – especially if milling out a workpiece from a solid metal block – are all significantly higher.

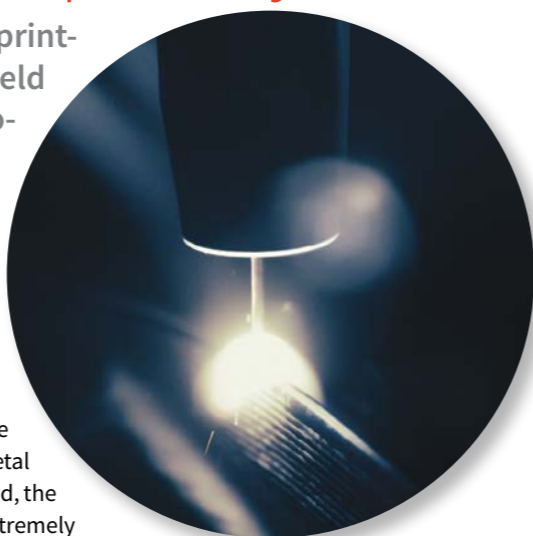
What is additive manufacturing?

There are a number of generative production methods for metal components. Es-

entially these can be divided into two fundamental types: powder-based processes and wire-based processes.

In powder-based processes, the layers are built up using molten metal powder. The most common method, the powder bed process, produces extremely precise results, but is somewhat slow in production. Wire-based processes, on the other hand, build up the component by melting a wire-shaped filler metal, requiring the use of a laser, electron beam or arc. These processes have high deposition rates and therefore help to cut production times.

Fronius' wire-based additive manufacturing solution uses the gas metal arc welding (GMAW) process and offers high deposition rates – up to four kg/h with steel materials, with multi-wire solutions potentially giving rise to even higher deposition rates. In addition, using GMAW and wire offers a number of other advantages: equipment and material costs are minimal – all that is needed is a suitable welding system – and there are no requirements for



The reversible wire electrode used in the CMT welding process promotes precise spatter free droplet detachment. Short circuit times are therefore prolonged, which reduces the heat input, creating a 'cold' but very stable welding process.

costly peripheral equipment, such as the vacuum chambers needed for the electron beam processing.

In comparison to powder-based processes, wire additive manufacturing also benefits from the immediate availability of a range of certified wire types. Since the use of metal powder is a relatively new technology, there are relatively few powder-based materials to choose from, as it can take years to acquire the necessary certification and to produce data sheets,

'Cold' CMT welding for strong layers

A stable welding process and effective heat dissipation are essential for large-scale 3D-metal printing. The welding process needs to deliver sufficiently low heat input so that when a new layer is applied, the existing layers does not remelt. In other words, the process needs to be as 'cold' as possible. Furthermore, the weld layers need to be continuous, spatter-free, and consistent. If any flaws were to occur, these would be replicated in each subsequent layer.

The CMT GMAW process from Fronius and its process control variants meet these requirements. They produce a stable arc and a controlled short circuit with prolonged short circuit times. This means that the heat input is lower, and the material transfer is practically spatter-free, which helps to prevent flaws.

Two process control variants of CMT



With wire-based additive manufacturing, components are welded layer by layer to near right size geometry before being mechanically machined and polished.

are particularly well suited to metal printing using wire. One is the CMT additive process characteristic, which has been optimised for large-scale 3D-metal printing. It achieves high deposition rates while transferring very little heat into the component.

The new CMT Cycle Step variant reduces the arc power even further by producing a series of spot welds, with the exact number of droplets deposited per spot as well as the pause time between spots being precisely controlled. Deposition spots of any size can be produced and precisely reproduced, offering a new level of energy control to the process. This particularly 'cold' process, however, does need more time to build up the layers, as the deposition rate is lower.

Real applications

Countless additive manufacturing components have already been produced using CMT welding technology from Fronius in a variety of sectors. These include fan impellers for the electronics industry, which are made from high-grade materials. Milling the workpiece is very expensive due to the high rate of material consumption, while casting is not always able to meet the critical metallurgical properties required for walls just 1.5 mm thick. With wire-based additive manufacturing using the CMT Cycle Step innovation, these fan impeller blades can be produced from a nickel-based alloy using the additive approach. It is even possible to repair components using this additive manufacturing technique.

Fronius has also implemented a solution with a partner in the aviation sector. Titanium is a frequently used material in aircraft construction, thanks to its tensile strength, resilience, corrosion resistance and low weight. A majority of titanium components are manufactured using subtractive methods, however, whereby up to 90% of the material is milled away. This causes high costs, long machining times, and costly tool wear.



CMT welding solutions can be adopted with ease, making wire-based additive manufacturing a much more accessible alternative to metal machining.

Titanium components produced using wire-based additive manufacturing, on the other hand, only need machining to produce a polished surface. The components produced using CMT do not exhibit any signs of lack of fusion and have impressive metallurgical properties. Tool costs, machining times, and wear can be reduced, bringing overall machining costs down significantly.



Key factors determining the quality of a component produced using wire-based additive manufacturing include arc stability of the welding process and low heat input. Fronius' CMT process fulfils these requirements.

The new Fronius CMT Additive Pro

Successful metal additive manufacturing is associated with a set of specific challenges, which include achieving the target geometry; adequate material properties; heat dissipation and distortion; process stability and feedback. The new CMT Additive Pro from Fronius includes some very specific features help to overcome these challenges.

- Firstly it includes a new deposition rate stabiliser. This enables the wire feed speed to remain almost constant throughout the process, allowing the exactly required build up to be maintained despite varying external influences.
- A Power correction feature now enables the wire feed speed and power to be varied independently of each other. This allows the reinforcement to be reduced for improved layer height consistency at connecting points. It improves control of the weld seam flow at the and enables the energy input to be reduced as inter-pass temperatures increase.
- CTWD measurement: This is an additional sensor signal for manipulator control and position correction. It enables the contact tip to workpiece distance

(CTWD) to be varied while welding to maintain the correct balance between resistance heating and arc heating.

- Pulsed HotStart: Like the hot start function in TIG welding, this function uses synergic pulsed arc welding at the start to guarantee sufficient penetration and adhesion: without adjusting the operating point and while keeping the layer height almost constant in the weld-start area.

"The new features of the Fronius CMT Additive Pro make wire additive manufacturing an even more cost-effective and flexible alternative for component production. All the new additive manufacturing features are available on the iWave AC/DC Multi-process Pro with the CMT welding package and the new additive manufacturing (AM) interface," says Edric van der Walt of Fronius South Africa.

"The CMT welding solution can be adopted with ease, making additive manufacturing a much more accessible alternative to metal machining," he concludes.

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The Fronius CMT Additive Pro makes wire-based additive manufacturing a flexible alternative for conventional metal component production.