AMazing – industrial gas innovation in Additive Manufacturing showcased at MTC2

By Stephen Harrison | 12 October 2018

The focus was on additive manufacturing (AM) and industrial gas applications at the 2nd Munich Technology Conference on Additive Manufacturing (MTC2) in Germany this week.

Running from 10th to 11th of October in Munich, the MTC2 advanced discussions among world-renowned decision-makers and leaders from industry, academia and politics alike.

Described as a magnet for the AM community, the main focus of the conference was the industrialisation of AM and proved a meeting point for the world's leading companies operating in the AM ecosystem.

Airbus, Boeing, BMW and Stryker were there speaking as end-users, while the AM machine maker Oerlikon was a keynote speaker and sponsor. GE and Siemens, both of whom are deeply involved as AM users within their own manufacturing operations and as systems suppliers to the industry, were as vocal at the event.

To make a case for collaborative partnerships which could accelerate the industrialisation of AM and to present innovative industrial gases applications in AM, Linde was represented by Dr. Christian Bruch, member of the Executive Board with responsibility for Engineering, Technology and Innovation.

The buzz of excitement in the workshops was tangible at the prospect of some of the technologies on display.

Mechanics mirroring nature

Additive Manufacturing (AM) is described as a true example of mechanics mirroring nature. Corals grow in the ocean by a process of additive manufacturing to produce delicate fan shaped, or tube shaped, structures; a beehive is built up from layer upon layer of beeswax to form a honeycomb. These structures are constructed in an additive way.

The processes of milling, drilling or lathing metal that might be used for production of mechanical components today are all subtractive manufacturing techniques. Competing with these traditional approaches, AM is a rapidly growing manufacturing technique. At present, it finds niches where it is simply able to produce shapes and forms that are not possible to create using conventional subtractive techniques. These parts simply have better functionality, such as reduction in automotive engine fuel consumption or higher power yields from natural gas-fired power turbines.

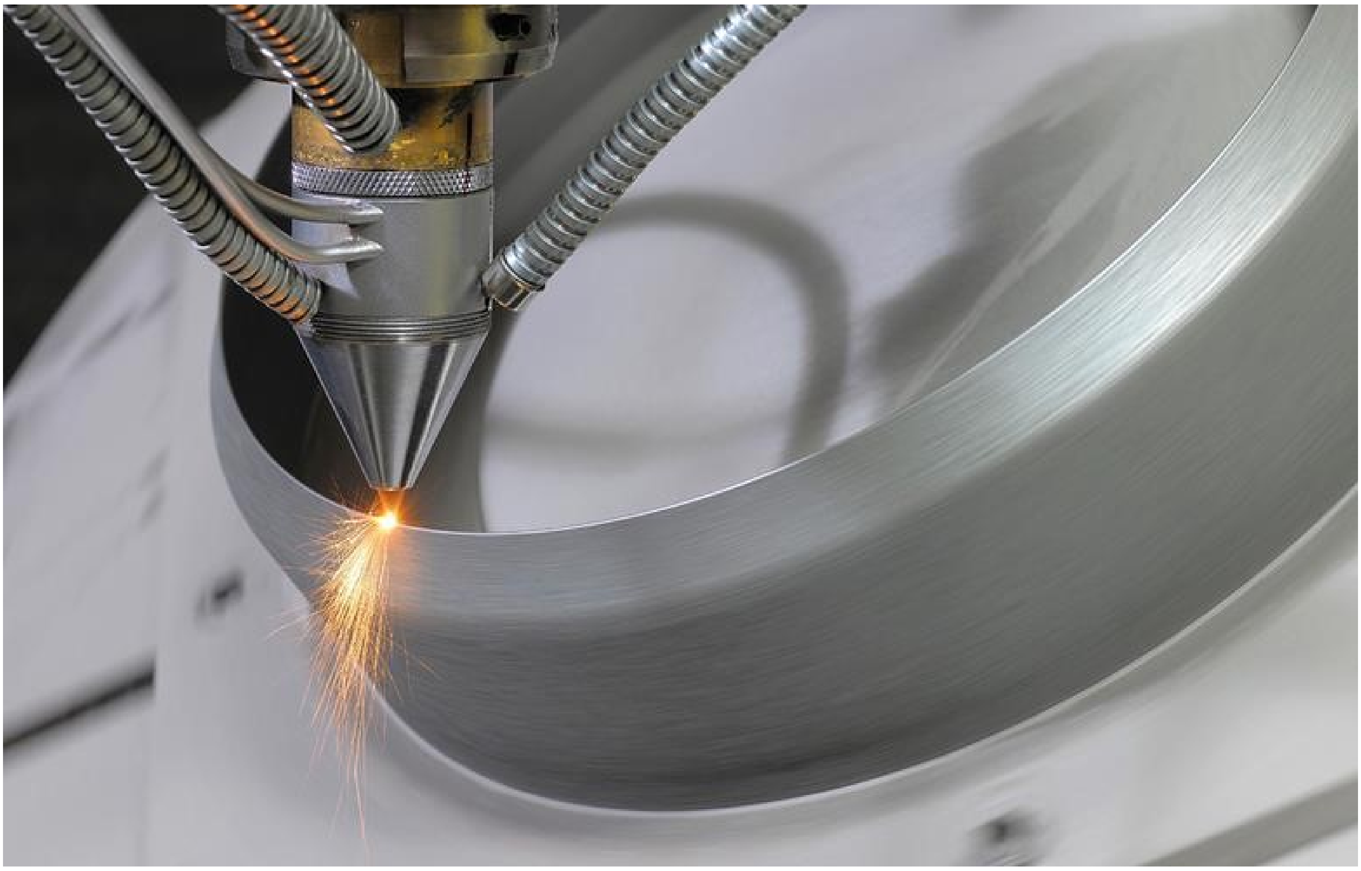
Applications of additive manufacturing include the layer-by-layer construction of power turbine components of complex geometry and the creation of highly durable surgical implants, such as knee joints. The process relies on a laser that is used to melt a powdered metal. There are similarities with sintering, because metal powers are used but, unlike sintering, there is no mould to define the shape, only a computer-controlled design and the subsequent addition of multiple layers of metal powder.

There are also similarities with welding, because argon is required as a shielding gas to ensure that the molten metals are not disturbed by the presence of moisture, oxygen and nitrogen.

Whilst the laser melting process is at the heart of AM, the value chain is also a consumer of a diverse range of industrial gases, as Christoph Laumen, Head of Application Technology for EMEA was keen to point out in an exclusive interview for **gas**world. "Gases are consumed by companies, such as GE, when they make titanium powders for use in the AM machine. These powders are extremely fine and they have an huge surface area so they will react with oxygen in the air within a matter of seconds to form undesirable coatings of metal oxides."

"So, inert gases for packaging during transportation and storage are essential. Inside the AM machine, it is essential to remove oxygen and moisture before the melting process can begin and this can be achieved with argon. Whilst nitrogen is also an inert gas and would be a lower cost option than argon, its use at this point in the process would be like adding poison, because, metal nitrides would form and transform the material structure and render the parts useless."

The role of industrial gases does not end in the AM machine. Laumen completes the picture, "After parts are produced, they might need to be cleaned or undergo heat treatment. In these areas we have also adapted existing technologies such as the use of dry-ice shot blasting to clean components and the application of gases for heat treatment. Leveraging our expertise in this way will help to accelerate the industrialisation of AM."



Standardisation

When compared to CNC machining, the AM sector is still in a state of infancy. According to Max

Rehberger, Additive Manufacturing Expert at TÜV SUD, "The main weak spot in the quality control of an AM process today is variability of the human interactions with the process and a focus here is made during our certification audits."

End-users commented that it has sometimes been the case that two AM machines purchased from the same supplier with the same model type can perform in very different ways: the AM machines are simply not manufactured in a standard way. Metals powder suppliers lamented the lack of standards for packaging so that their powder barrels could be interchangeable between AM machines and drive greater competition and flexibility. Many of the delegates were crying out for more standards in this sector in the future.

On the opposite end of the spectrum, the gases infrastructure is regarded as reliable and more than capable of delivering the quality levels that the AM users need. As a proof statement around this, the metals powder batch control requirements for AM metal powders that are imposed in the airline industry for production of aviation parts are not applied to the used of industrial gases. The users simply trust the purity of the gases and are focusing their attention on other weak links in the chain for standardisation. Rehberger confirmed that there are, at present, no calls within the AM sector to standardise the gases required for AM.

Gas innovation will add value

Though industrial gases used in AM are not the target of immediate standardisation for quality control, the potential to develop innovative uses of industrial gases is clearly seen across the AM ecosystem.

In several workshop discussions, AM technology users asked about the possibility of introducing reducing gases such as hydrogen or carbon monoxide to speed up the removal of oxygen prior to the melt taking place. And in his keynote address, Dr. Bruch demonstrated that the combination of helium with argon can increase processing speed by more than 30%, which is a tremendous boost to productivity and asset utilisation. Laumen of Linde commented further, "Our welding gases pedigree at Linde goes back decades and we are applying that knowledge to gases for AM. Years ago, we learned that for some processes the addition of helium to welding gas mixtures can increase the travel speed be 30%. When we started to test this concept in our AM laboratory, we found similar results."

The buzz of excitement in the workshops was tangible at the prospect of 30% faster melt speeds. Participants noted that, in addition to an increase in productivity and machine utilisation, the faster production of parts means that more parts can be produced within the lifetime of a laser, thereby reducing the capex and maintenance costs significantly. And, if there is one thing that the end-users such as GE, Siemens, BMW, Airbus and Boeing would love to see, it would be reductions in operating costs for their AM production lines.