AM behind the scenes

Liz Nickels

Liz Nickels spoke to Sintavia, a Florida-based 3D printing company founded in 2012, about how it plans to improve AM part quality by ensuring that the background to the printing process is improved.

More and more experts are finding that additive manufacturing (AM) is not the one-step process that was once proposed. Issues with quality, repeatability and how to quality parameters continue to crop up, along with a need for careful regulation of the industry. Companies such as EOS, with its quality assurance program, and Concept Laser’s QM Meltpool 3D, are now realizing that to ensure high quality production parts, a lot of work needs to go on behind the scenes both before, after, and during the actual printing process. Sintavia, based in Davie, Florida, is an example of a company that aims to focus on the whole process to improve parameters and the overall quality of the finished part.

The company, a relative newcomer to the AM industry, was formed in 2012 by Neff Capital Management LLC, a private equity firm based in Ft Lauderdale, Florida, with aim of manufacturing production parts for aerospace and defense. The funding of Sintavia included a US$10 million initial capital investment, to be rolled out over a year as the company developed. In March 2017, the company closed an additional US$15 million round of equity financing from its primary investor to be used to create additional manufacturing capacity and facility expansion in 2017 and 2018.

From the first, Sintavia tied its colors to the mast regarding the importance of quality control. ‘We are excited to be a part of the coming industrial revolution within the aerospace and defense industry,’ said Brian Neff, founder and CEO of Sintavia, back in 2015. He made a big claim for the future company. ‘Over the next few years, as more and more production is shifted to AM within this industry, serial manufacturers with exceptional quality control, like Sintavia, will be in high demand by the OEMs.’

In-house capabilities

The company’s claim is that it possesses the largest range of in-house AM equipment globally. Currently, it offers a varied range of processing equipment covering all stages of the process, besides its six 3D printers (three SLM Solutions 280HL 400W twin laser machines, an EOS M290 400W laser machine, a Concept Laser M2 400W laser machine, and an Arcam Q20+ electron beam machine). These include a vacuum heat treatment furnace, an industrial CT scanner, a wire electric discharge machining (EDM), mechanical testing equipment (including high temperature tensile, fatigue, and creep testing), a blue light scanner, a vertical machine center (VMC)/lathe, a metallurgical laboratory (including a scanning electron microscope and an inductively coupled plasma spectrometer), and a micro powder lab. Its metallographic preparation capabilities including sectioning, mounting, grinding, polishing and etching.

‘Sintavia created a process that begins in our metallurgical laboratory by examining the raw material at a microscopic level,’ said Neff. ‘The process continues with special handling of the materials during printing, post production with HIP treatment for density, CT scanning to verify print quality, and mechanical testing in our certified laboratory.’

Sintavia also possesses a hot isostatic press (HIP), which was initially supplied by HIP specialist Quintus in June 2016. The model QIH 15L press is equipped with Quintus’s uniform rapid cooling (URC), which, by incorporating densification and heat treatment in the same equipment, can shorten cycle times. The press features a hot zone capability of 7.3 × 19.7 inches (186 × 500 mm), enables pressures up to 30,000 psi (207 MPa), and handles temperatures up to 2550°F (1400°C). The complete
unit features with gas compressing system, cooling unit, transformers, electrical cabinets, and pressure vessel mounted in a 103 × 73-inch skid.

According to the company, a HIP is one of the more vital parts of the metal AM process. ‘Without HIP technology, AM parts are susceptible to porosity and lack of fusion,’ said Neff. ‘HIP allows for near 100% net-density parts.

The need for HIP-ing isn’t always immediately apparent, according to Sintavia COO and president Doug Hedges. ‘Traditionally cast parts and 3D-printed parts look dense, but when examined under a high-fidelity scanner, microscopic voids and gaps can be revealed,’ he told Metal Powder Report. ‘These voids can cause stress fractures and reduce the longevity of the component lifecycle. HIP is very important in the production of critical parts because the process essentially eliminates pores or voids within a metal component.’

Increasing density
The HIP process uses heat and pressure to compress the part and remove voids in any metal part,’ he explained. The process is the simultaneous application of high temperature and high pressure that compresses the part to ensure near 100% net densification. The temperature, pressure, and cycle time are all precisely controlled during the HIP process. Components are heated in an inert gas, generally argon, while isostatic pressure is applied uniformly in all directions, causing the material to become plastic, and allowing internal voids to collapse under the differential pressure. ‘The most pronounced benefit is that fatigue properties are improved since the density is increased,’ said Hedges. When performed properly the fatigue life of a HIPed part can be improved tenfold.’

‘As the AM process continues to penetrate various supply chains, not just aerospace and defense, you’ll see more applications requiring HIP-ing,’ added Neff. ‘For certain very critical parts, HIP will become more or less the standard. We believe that the HIP process will always be an integral part for certain critical parts that use metal AM.’

Hedges agreed. ‘While heat treatment is widespread, there is not a lot of HIP capacity available today. As the demand increases, we wanted to stay in front of the curve, controlling our own HIP needs.’

Scanning parts
In February 2016 Sintavia added to its range of machines with a Nikon XTH 320 CT scanner for porosity analysis and nondestructive examination of the internal networks of AM manufactured components. The scanner features 225 and 320 kV microfocus X-ray sources that are used depending on the density of material and resolution necessary to analyze internal passages and cooling channels. The 225 kV source is equipped with a reflection target creating a 3 micron spot size which makes it possible to generate detailed imaging for aluminum and titanium parts. The 320 kV source is used to penetrate through larger parts or higher density alloys such as nickel alloys and stainless steel with high resolution and magnification.

‘Quality control is the number one reason Sintavia incorporated the CT scanner in our manufacturing process,’ said Hedges. ‘Adding this high-fidelity scanner to our comprehensive manufacturing and testing suite allows us to meet and exceed customer quality specifications.’

Improving parameters
An important aspect of quality control of serially produced AM parts, according to the company, is based on two aspects – parameter improvement and part finishing. ‘Optimizing for the AM process is a difficult task given the numerous parameters involved throughout the entire metal AM life cycle,’ the company admitted.

In January 2016, the company announced that it had developed full end-to-end parameters for producing AM parts in F357 aluminum, as well as other Al–Si alloys.

‘We are seeing an increased demand for AM Al–Si parts from both the aerospace and automotive industries,’ said Hedges. ‘With Sintavia’s comprehensive manufacturing capabilities, we have developed processes to make F357 aluminum specimens and quickly test them to demonstrate they meet or exceed these industries’ strict validation parameters.’

I asked Hedges about the specific issues around 3D printing aluminum powder, when compared to titanium, for example. ‘There are many types of aluminum alloys used in aerospace manufacturing applications and more alloys are being created every year both inside and outside the additive metal industry,’ he said. ‘For instance, both Aluminum A357 and Aluminum F357 are very common aluminum casting alloys in the aerospace industry. The difference between A357 and F357 is that F357 is beryllium free. Although beryllium as an alloy offers some performance benefits to the finished part, there are severe environmental and health risks associated with beryllium.

‘Printing aluminum requires a more controlled process than other alloys such as titanium or stainless steel. Aluminum components are valued in aerospace for their lightweight characteristics, which is important for flight hardware but also makes it prone to complications if not strictly controlled. Humidity is another important variable when printing with aluminum. Because aluminum powder must stay under 8% humidity, it is vital that the production process be highly controlled from beginning to end.’

The company said that by using a procedure including pre-build material analysis and post-production heat treatment and stress relief, it could produce AM components that could to exceed original design strength by up to 125% at net densities of near 100%.

The difference between cast and HIP-ed, 3D printed materials.
Samples of F357 aluminum powder, used in the AM process.

‘As an industry, print parameters for aluminum are weak or non-existent with the exception of the most common alloy – AlSi10Mg,’ added Neff. ‘What Sintavia has done with F357 is blaze a trail into an unknown territory in 3D printing. The reason we are able to undertake this proprietary process is because of the resources we have to test and control production from beginning to end.’

Focus on accreditation
In November 2016, the company received AS9100 Revision C certification, becoming, it says, one of a few number of companies to receive the quality certification for the metal AM process within the aerospace and defense industry.

‘AS9100 is recognized as the global standard for quality systems, even beyond the aerospace and defense industry,’ said Hedges. ‘For Sintavia to achieve this certification strictly for the metal AM process is quite an achievement and a recognition of the company’s outstanding quality system.’

Certification to the AS9100 standard could help ensure consistency in precision manufacturing for critical applications within those industries.

In December of the same year, Sintavia’s metallurgical laboratory received ISO 17025 accreditation by the American Association for Laboratory Accreditation (A2LA). According to Hedges, Sintavia was the first dedicated AM manufacturer to achieve ISO 17025 accreditation. ‘Serial production is all about serial quality, and this achievement speaks to our commitment to the highest standards at every step of AM production,’ he said.

Previously, AM manufacturers offering ISO 17025 accredited testing had to use independent laboratories for powder and material validation. While quality analysis can be achieved by shipping samples to a third-party laboratory for powder analysis,

Sintavia’s first HIP machine, supplied by Quintus in June 2016.

Sintavia uses a Powder Bed Fusion (PBF) AM process to produce production quality metal parts with three SLM Solutions 280HL 400W twin laser machines, an EOS M290 400W laser machine, a Concept Laser M2 400W laser machine, and an Arcam Q20+ electron beam machine.
metal density testing, and quality assurance verification, having an accredited laboratory within the AM production facility means faster analysis and complete security of the process, Hedges added.

‘Because AM is such a new industry, there is still much to be discovered about the impact of material quality on the production of parts,’ he told Metal Powder Report. ‘When Sintavia gets a shipment of aluminum powder – or any other material – regardless of the vendor, it must first be analyzed in our lab on-site. This analysis is a critical step for success. Molecular size distribution, chemical composition, and powder porosity are all important factors in ensuring a successful and optimal outcome. Before a run, powder is tested to ASTM and Sintavia specifications. In-house testing includes microscopic analysis using an electron beam microscope, gas analysis, and density flow testing.’

Bigger picture
The company’s main focus – like much of the industry – is on scaling up the process, in this case specifically for aerospace applications. But how will this be achieved? ‘The technology for AM is advancing at a fantastic pace which means 3D printers are physically able to produce higher volume parts at speeds faster than ever before,’ said Neff. ‘New technology in the AM industry is quickly closing the gap between traditional manufacturing and casting methods and AM.’

Sintavia itself is scaling up by building a new manufacturing plant in 2017 that will reportedly quadruple its production capacity for AM components. The facility will have a floor space of around 50,000 ft² on two levels, an automated powder handling system, power backup system, inert gas farm and a cooling system.

‘Sintavia is committed to leading the charge in developing an OEM-aligned supply chain for metal AM within North America for precision industries, in particular aerospace and defense,’ affirmed Neff. ‘No other company in the world has the breadth of in-house capabilities as Sintavia, and as we move into our 50,000 ft² production facility in early 2018 we will be well-positioned to meet our customers’ increasing demands for parts.

The company is also looking into developing applications a little more ‘out there’ than defense and aerospace.

‘In addition to aerospace/automotive industries, the demand for lightweight aluminum components is also found in the space industry,’ said Hedges. ‘As with components in the aerospace and automotive industries, components for space applications have very high validation requirements. Because space components are routinely subjected to extreme temperature differences, Sintavia offers mechanical testing in ambient, elevated, and subzero temperature environments.’

Sintavia; www.sintavia.com