COLIBRIUM ADDITIVE
a GE Aerospace company

Get the facts on coarse Ti64

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At RAPID + TCT 2024, AP&C - a Colibrium Additive company - is introducing a coarse Ti64 solution to lower part cost.

AP&C and Colibrium Additive – a GE Aerospace company – have validated a parameter to print high quality parts from coarse Ti64 powder on laser powder bed fusion (L-PBD) metal 3D printers. This powder offers the same quality material as AP&C's finer powders, but with larger-size particles.

We caught up with Javier Arreguin (top), Product Manager – metal powders at AP&C, and Patrick Krappmann (bottom), Lead Engineer - Materials & Process at Colibrium Additive, to discuss this new solution.

How important is Ti64 to the additive industry?

Ti-6Al-4V (Ti64) is a key material for additive manufacturing especially in the orthopedic industry, alongside cobalt chrome. There are also many Ti64 applications in the aerospace sector and is also used consumer goods products like bicycle parts, so it is relatively easy to find new niche applications for it.

Ti64 has already been widely adopted by the additive community compared to other alloys, which has led to optimized parameters for this material—making it easier to find business use cases.

Additive Ti64 parts have been widely qualified for mass production of biomedical and aerospace applications to replace conventionally manufactured parts and the Ti64 powder demand have been quickly growing year after year because of that.

There have also been several publicly funded projects surrounding Ti64 and last year we saw an increase of Ti64 related customer requests for benchmark build jobs, so we continue to observe interest and demand for this material across different markets.

What is coarse Ti64?

When metal additive manufacturing was developed, it needed metal powders, but the data was lacking to identify the "ideal" powder and the volume was low. So, the industry started with leftover powder from other conventional manufacturing technologies (like metal injection molding for steel).

There was a need for fine powder, but because the layer thickness and laser power were low, it was soon identified that 0-15 µm was creating issues.

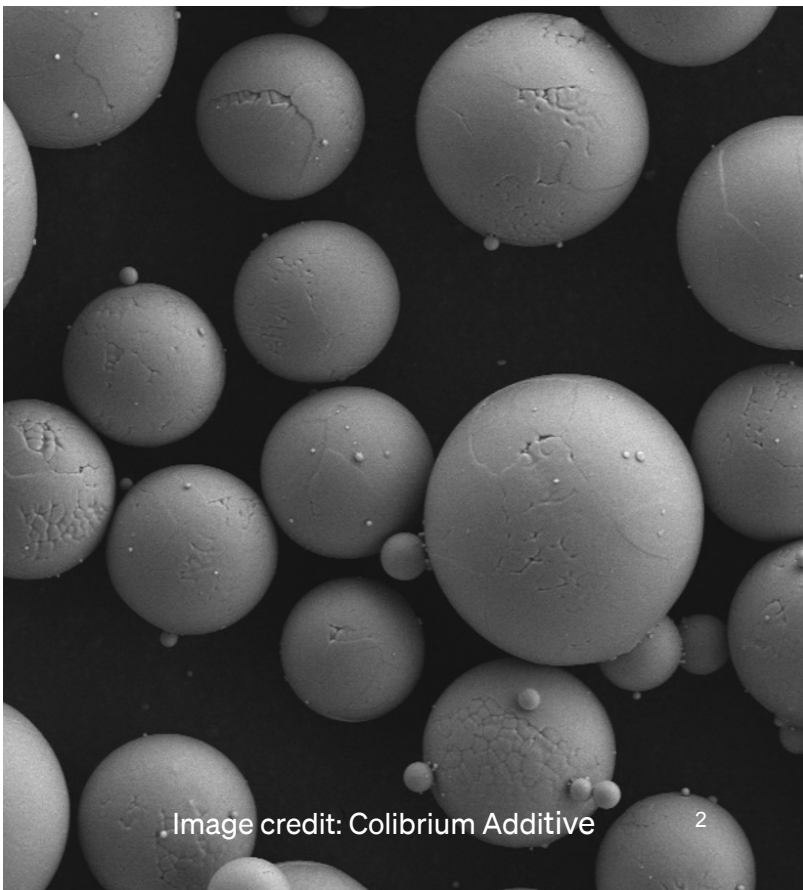

Image credit: Colibrium Additive

Thus, the emergent laser powder bed fusion (L-PBF) technologies selected the 15-45 µm and 15-53 µm particle size distribution (PSD) to develop the deposition parameters although AP&C's Advanced Plasma Atomization process produces powders ranging from 0 to 180 microns. Over time, technology reached the level of maturity required by the industry and finally parts were qualified using these same PSD with different optimized deposition parameters.

L-PBF technology is now the largest market for spherical Ti64 powders but by using only the finer fraction of the "as-produced" PSD, coarser Ti64 powder becomes available and in need of a market. However, there is no technical reason why coarser Ti64 powder could not be used in the L-PBF process with slight fine-tuning on deposition parameters. Larger Ti64 particles exhibit the same quality as the currently used 15-45 µm and 15-53 µm powders as they have been created using the same validated process.

In fact, similar coarse PSD are used in electron beam powder bed fusion (EB-PBF) and direct energy deposition (DED) with great results, but the penetration of those technologies remains small compared to L-PBF. Initially, one of the reasons to offer this coarser powder to L-PBF users was to respond to demand from the additive manufacturing community we support, which for several years have been inquiring about more cost-efficient powders and multiple efforts to reduce additive manufacturing environmental footprint.

Also, academic research and our own internal data has shown that using larger particles with a tuned deposition process produce high-quality printed parts with comparable mechanical properties and excellent process stability.

After extensive work and validations, we got to the point where we are today, where we can commercialize a parameter for the Colibrium Additive M2 platform for coarse Ti64.

This has been motivated by the need to find new business opportunities without sacrificing quality. AP&C is ready to work with additive technology users to identify cost-reduction opportunities with a premium-quality product and a sound supply chain.

The additive manufacturing community has now reached a level of maturity where we know that we can find new applications and parts that will justify all the development and expenses to validate this new particle size distribution and its parameters, as it will bring an important raw material cost reduction in the roadmap.

Another important advantage to highlight for coarse Ti64 is that it is also safer than finer powder Ti64 since the higher PSD is substantially less reactive. Powder handling, storage and reuse could be significatively simplified; moreover, local regulations of powder storage are easier to meet.

How is coarse Ti64 safer?

Coarse Ti64 powder is significantly less reactive than finer Ti64 powder, making it safer for handling and storage. The larger particle size reduces the active surface area of the powder, reducing its reactivity. Particularly, coarse Ti64 powder is not classified as flammable solid (while fine Ti64 is) and, more importantly, its minimum ignition energy (MIE) is high enough that the powder is not sensitive to electrostatic discharge which can change the applicable safety controls associated with using this powder.

By increasing the safety of the powder and reducing its reactivity, you can store more powder, and the storage is less disrupted in the facilities of the end user.

Does the quality of coarse powder Ti64 differ from fine powder Ti64?

It doesn't. The coarse powder is produced at the same time as the fine powder with the same exact quality requirements. The difference in the coarse powder is that it will be less reactive with even some improved physical properties, such as flowability, which in some cases plays a key role in deposition process stability. However, fine-tuning the machine deposition parameters will need to be done according to the new powder characteristics to ensure you have a sound and reliable process.

Quality-wise, there is no change. The powder follows the same qualified production process, is produced in the same equipment, and undergo the same quality controls as the premium quality fine powders you already use. AP&C's certified quality management system already include the production of the coarse powder as well as all other AP&C products.

Does coarse Ti64 make the additive manufacturing process more sustainable?

In our industry, many link sustainability with recycling. Obviously, recycling is better than wasting, but by nature, to recycle metal, the material will go through a melting step that requires a lot of energy.

For us, one of the keys to be sustainable is maximizing the usage of the produced powder by lowering waste but also lowering the need to recycle off size powders. Making parts with all the “as-produced” powder is the best way to lower the energy consumption footprint. Luckily, AP&C’s high-quality powders are produced in Québec (Canada) where much of the power comes from hydroelectricity, thus ensuring a very low carbon emission for the atomization process.

Coarse powders have a higher potential for reusability compared to finer powders. Titanium powders are typically limited in their reusability due to the oxygen pickup after multiple builds. Coarser particles pick up less oxygen because they have a smaller active surface (aspect ratio between surface area and volume) compared to finer particles.

So, coarser powders pick up less oxygen, meaning that they can be reused more times—increasing the life cycle of the powder and increasing the impact on the sustainability.

Is coarse Ti64 less expensive?

Yes, because if we sell a larger yield of the as-produced powder from fine to coarse, then we can bring down the cost of all the powders—including the finer powders. Coarse Ti64 powders pricing could be competitive when compared to steel powders, which opens a huge window of potential application opportunities (even more knowing that Ti64 have about half the density of steel, you thus need half the quantity to make the same part).

The choice between the finer powders and the new coarser powders will be down to each individual additive user, because, while coarser powders have several advantages, the surface roughness of the part does change, so they will not be for everyone. For applications where a higher surface roughness is not an issue, coarse powders offer a cheaper powder alternative.

Is coarse Ti64 already available to customers?

Coarse Ti64 is available now. It is a material we are producing and are ready to serve the needs of our existing customers and the wider additive manufacturing community.

Overall Outlook

Ti64 has become a key additive material in the orthopedic and aerospace sectors. While there has often been a consensus around using finer powders on L-PBF systems, research has shown that tweaking the parameter slightly, enables coarser powder to produce just as high-quality parts that could meet and exceed the standard industrial requirements.

The cost of powders often comes into question when developing new applications particularly outside of the orthopedic and aerospace sectors. Powders composed of larger-particles will offer a more economical alternative for those additive users willing to adopt them and will present a safer option from an occupational hazard perspective.

To find out more about how you can switch to a larger particle size powder in your additive application, get in touch with our technical team today.