



*6K Additive: Balancing Performance,
Quality, Cost, and Sustainability
in Metal Additive Manufacturing*

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6K Additive: Balancing Performance, Quality, Cost, and Sustainability in Metal Additive Manufacturing

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Summary

6K's proprietary UniMelt® microwave plasma process produces advanced materials used in additive manufacturing, battery manufacturing and other industrial markets. 6K's high-quality metal alloys enable your AM operation to balance performance, quality, cost, and sustainability.

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Insights

Let's be honest. No engineer, designer, or procurement professional will specify a material that puts their company at risk of delivering unacceptable parts. The last question they ask is, "How will a vendor's metal powders meet our sustainability goals?" First, they ask about performance, quality, and cost. Wouldn't you?

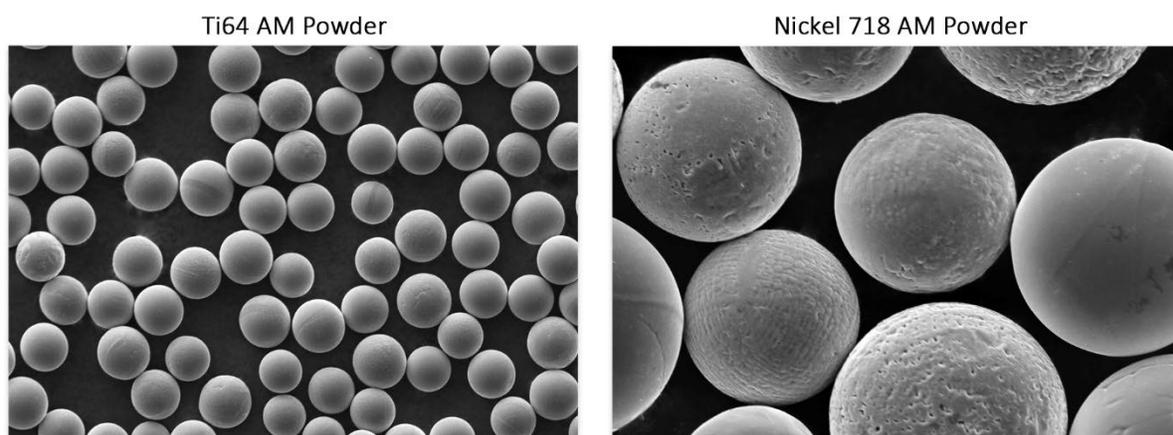
I understand. Fortunately, with UniMelt powders and alloys, metal additive manufacturing operations no longer face an either/or situation regarding profits and the environment. With 6K Additive, performance, quality, cost, and sustainability all balance.

About 6K and 6K Additive

[6K](#) is a leader in the sustainable production of engineered materials for additive manufacturing and lithium-ion batteries. The company's proprietary UniMelt technology is the world's only microwave production-scale plasma system. Its company name, 6K, represents 6000 degrees Kelvin, which is UniMelt's operating temperature and the temperature of the sun's surface.

6K's headquarters and innovation laboratories are located outside Boston, Massachusetts, a hub of the AM world, while its 6K Additive division and production facility is just outside Pittsburgh, Pennsylvania. The 6K Additive division specializes in sustainably sourced AM metal powder production and reclamation, using a proprietary milling and cleaning process that ensures contamination-free, high-quality powders. 6K Additive produces AM powders, including nickel 718/625, Ti64 grade 5/23, copper 18450/GRCop, stainless steel 316/17-4, and refractories like tungsten and tantalum, all made from sustainable sources. 6K's other division, 6K Energy, focuses on producing low-cost, sustainable battery material that accelerates the pace of battery production and the adoption of electric vehicles.

Figure 1. SEM of Ti64 and Ni718 Powders Produced in the UniMelt

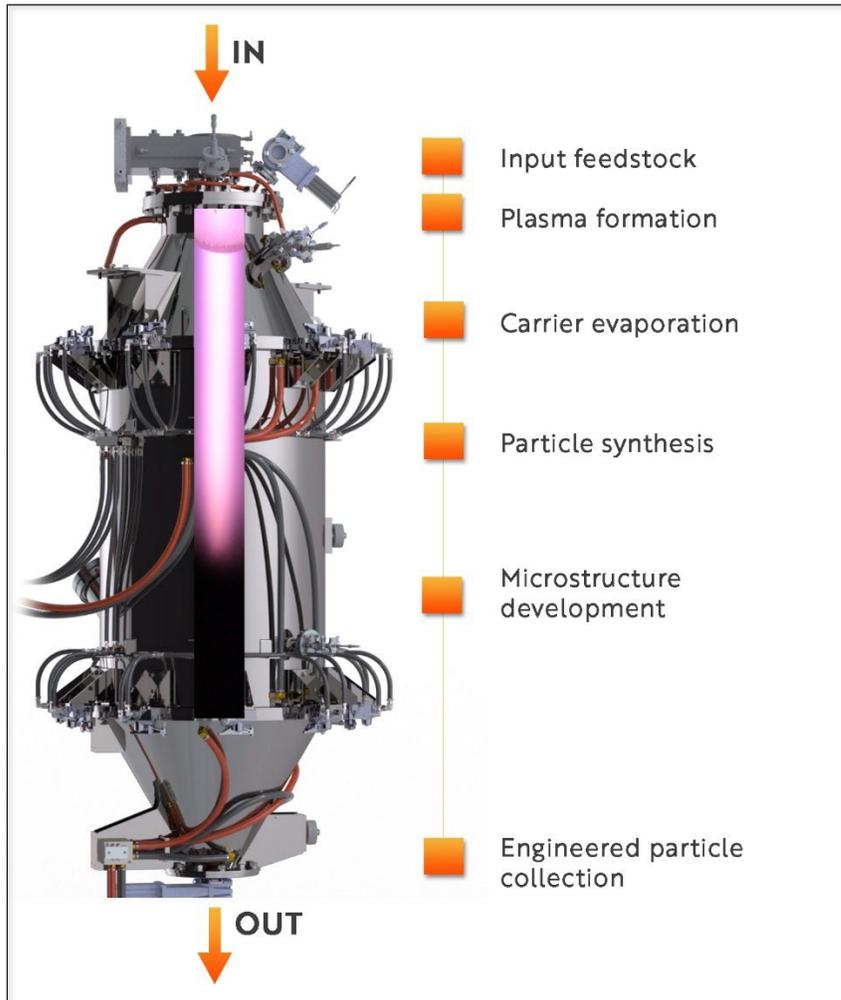


Source: 6K Additive

UniMelt Defined

6K's UniMelt system is a production-scale microwave plasma process that produces advanced materials used in additive manufacturing, battery material manufacturing and other industrial markets. The fast and environmentally friendly process uses virgin, scrap and used powder as feedstock to make high-quality metal alloys for additive manufacturing. The UniMelt platform has 99% efficiency (microwave to plasma), under 2 seconds process to spheroidized powder, and is 99.999% contamination-free.

Figure 2. The UniMelt Process



Source: 6K Additive

6K's UniMelt process generates extremely high powder yields with less energy, addressing the environmental shortcomings of the gas and plasma atomization processes. A significant AM benefit is that with UniMelt technology you can precisely spheroidize metal powders while controlling the chemistry and porosity of the final product, enabling you to produce parts that meet the quality specifications of the end-use part.

Gas and Plasma Atomization: Widespread and Wasteful

Gas atomization is the most common technique for creating metal AM powders and operates by heating metal or alloy into a molten melt stream, resulting in particles that typically range from 1 to 250 microns in size. But laser powder bed fusion, the most widely used metal AM technology, requires powder particle sizes of 15 to 45 microns, with some OEMs expanding to 20 to 63 microns. The consequence? A high percentage of the gas atomized powder is simply unusable because it falls out of the usable size range. The meager material yield burdens the remaining usable powder with high environmental and economic costs.

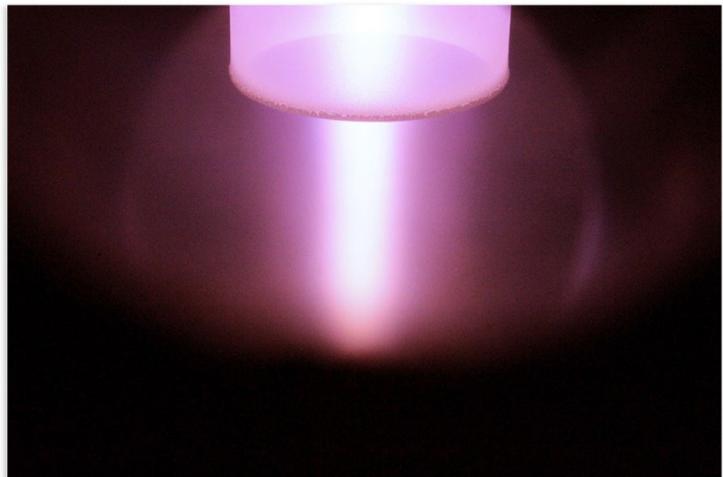
Plasma atomization uses wire as feedstock, which is then melted by plasma torches. In addition to the low yields of gas atomization, a significant plasma process drawback is the need to turn raw feedstock materials into wires. The production process to create metal wire can be limited, restricting the variety of AM powders available for plasma atomization. Notably, the few compatible materials are frequently sourced from countries like China and Russia, building in supply chain delays and contributing to a negative carbon footprint and potential geopolitical impacts. Using plasma atomization to make the few available AM powders from wire feedstock is a wasteful, unsustainable situation.

Microwave Plasma Atomization: Near-Zero Waste, Today

6K's UniMelt process uses either virgin or scrap metal as feedstock and consumes less energy in producing metal AM powders, addressing the environmental shortcomings of the gas and plasma atomization processes. Not only does UniMelt technology recycle customers' waste material back into the supply chain, but it also produces zero waste, minus less than 1% system loss.

A proprietary pre-process technique leverages 6K Additive's 30 years' experience up-cycling titanium for the aluminium alloy industry commonly used for aerospace and medical applications. Using feedstock from the manufacturing process, including used AM powders, support structures, non-conforming 3D prints, and certified chemistry machining scrap, allows 6K Additive to source materials economically and without reliance on overseas sources. UniMelt achieves nearly 100% yield within the targeted particle size distribution (PSD), whether creating metal injection molding, laser or electron beam powder bed fusion, or binder jet AM powders.

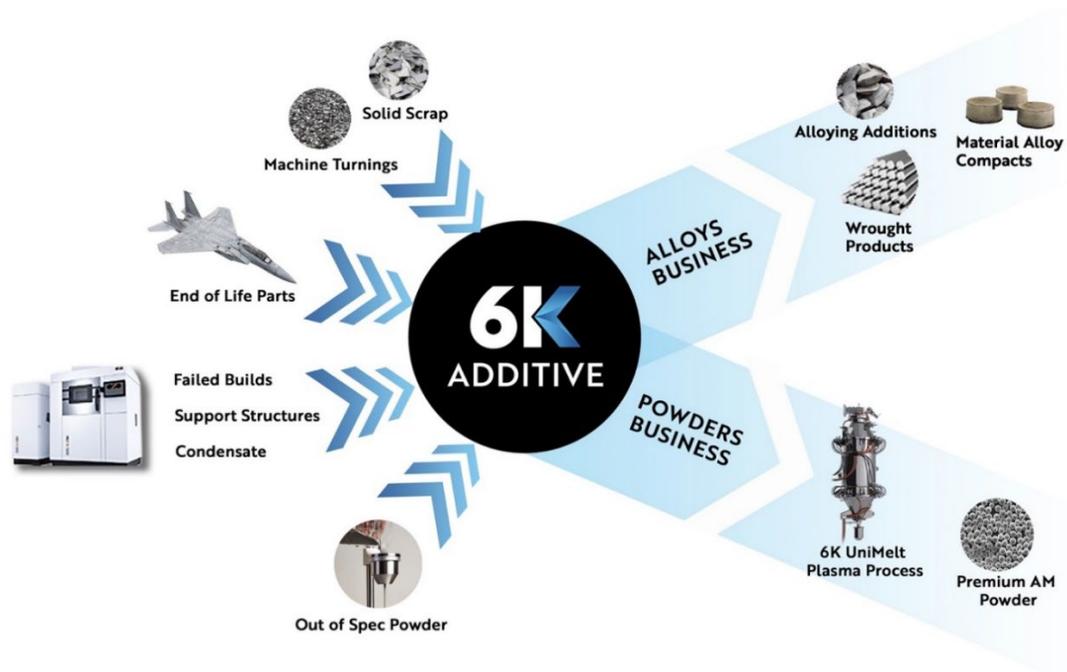
Figure 3. Red Plasma from UniMelt



Source: 6K Additive

Customers can also realize benefit by selling their scrap material to 6K Additive for credit toward their next metal AM powder purchase, creating an economic, circular, and controlled supply chain. For unique alloys, 6K Additive works directly with its customers to use their waste materials as feedstock for subsequent powder orders. This process is vital when customers develop special AM powder alloys that differentiate their metal parts.

Figure 4. Possible Powder Paths



Source: 6K Additive

Balancing Performance, Quality, Cost, and Sustainability

Companies base their conventional and additive manufacturing technology investment and operating decisions on four key elements:

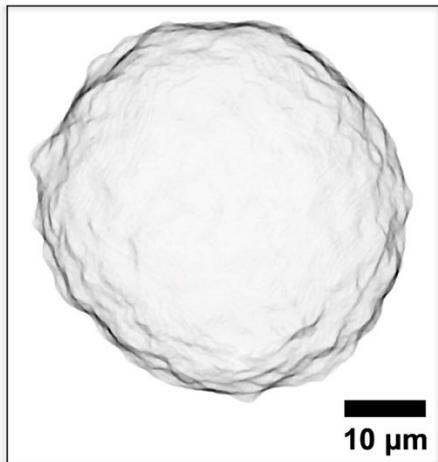
- Manufacturing performance
- Finished goods quality
- Raw material, labor, and overhead costs
- Production process and finished good sustainability

Let's consider how UniMelt enables your AM operation to balance these critical factors.

Premium Performance

The performance of metal powders produced from the UniMelt platform surpasses that of other providers' materials because the 6000K microwave plasma process utilizes a much lower gas volume during spheroidization. A uniform plasma beam eliminates gas entrapment within the particles, producing dense powder particles that are highly spherical, without satellites and no internal porosity, resulting in smooth flowability and higher tap density.

Figure 5. Zero Porosity



Source: 6K Additive

The UniMelt process leverages sustainable feedstock sources such as used powder, turnings, millings, etc., to produce an unlimited number of materials, including next generation engineered alloy powders, that have been impossible to make. The combination of a high-yield process and the feedstock flexibility means metal AM operations have more material choices than ever. 6K Additive's powders enable your applications to confidently push AM's boundaries while meeting or exceeding conventional materials' performance capabilities.

Cost-Effective Powders and Parts

Many of the factors that make the UniMelt process sustainable also make it cost-effective. By accepting used feedstock, failed builds, and AM process waste powder and turnings, 6K Additive sources materials economically and without relying on overseas suppliers.

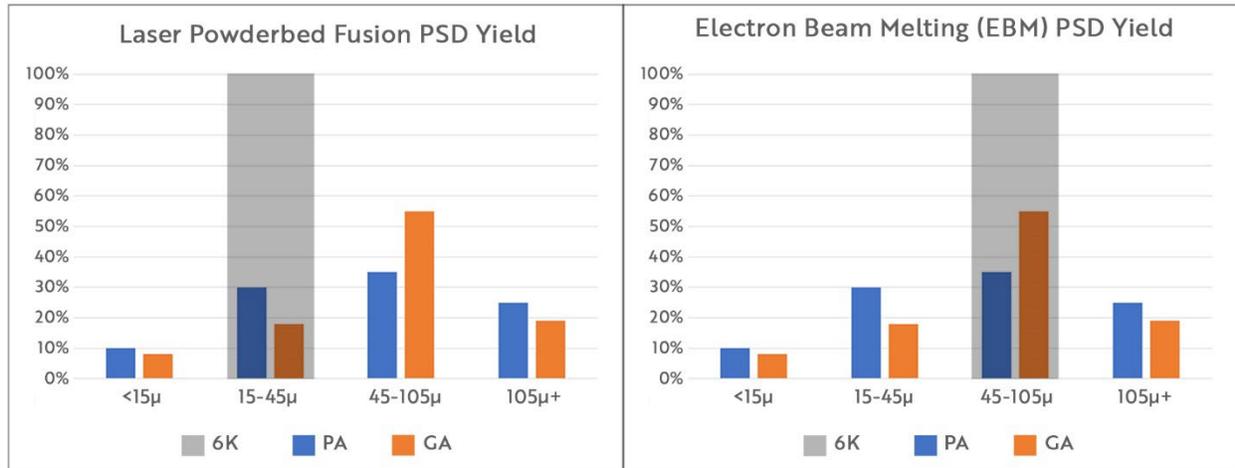
Significantly, the UniMelt technology also reduces hidden powder costs. Have you tracked the amount of unusable AM powder you pay to put in a landfill? Do you string out the number of times powder is reused to cut costs, hoping the blend of virgin powder, and used powder will meet your customers' quality and performance requirements? Do you have a room filled with used powder that you don't know how to dispose of properly or simply don't have the time to deal with it?

AM operations often use metal powders until the material falls out of specification or reaches an arbitrary limit. Conducting the in-depth powder reuse studies for each of the AM powders you work with and the widespread differences in customer part designs and performance demands can be very costly, especially when it involves several reuse cycles. Now you can return spent powders to 6K Additive for recycling into new material after a couple of production cycles, rather than hoping excessively reused powders will perform as required.

Demonstrated Quality

The shape, flow, density, and porosity of 6K Additive's powders are such an improvement that any AM operator will immediately see the difference. Gas atomized powders, for example, include many elongated particles that are under-finished. With the UniMelt process, the targeted PSD, consistent spheroidicity, and surface smoothness improve flowability, feeding of powder into the 3D printer, and helps with the density of the powder in the build chamber, thereby improving part quality and printer productivity. UniMelt technology is able to yield 100% PSD required for specific process types such as metal injection molding, laser or electron beam powder bed fusion, or binder jet AM powders.

Figure 6. PSD Chart showing 6K Additive’s yield for PBF and EBM requirements



Source: 6K Additive

Superior Sustainability

Many people assume AM is sustainable because it epitomizes digital production – you only produce what you need when you need it, so there is little waste. And with the ability to share files digitally around the world, parts can be made locally, without CO₂-generating transportation requirements. But the assumption ignores how the powder was created in the first place, which is a critical factor in determining true sustainability.

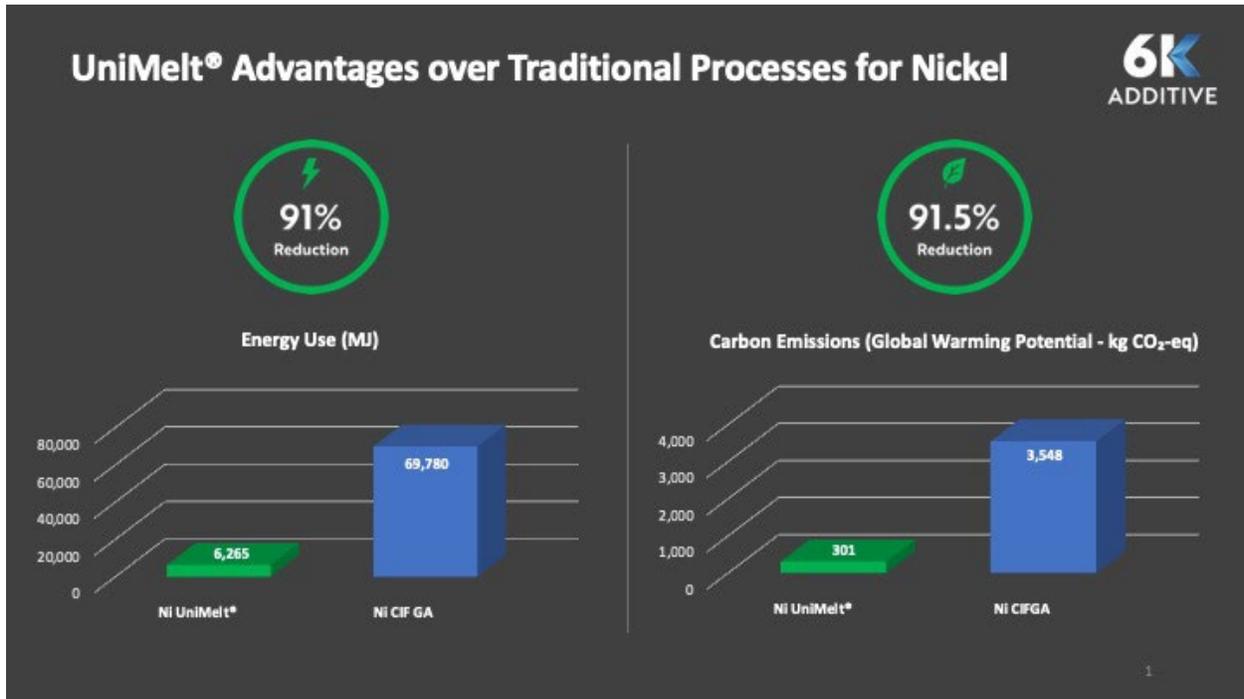
As mentioned, most metal powders used in AM processes are produced by either gas atomization or plasma atomization with sizable environmental price tags. Both methods consume prodigious quantities of energy with low yields and high waste. If a manufacturing process uses materials with a high up-front environmental cost, how can users claim to have sustainable manufacturing operations?

Two recent life-cycle assessments produced by Foresight Management uncovered significant reductions in the environmental impact of UniMelt nickel and titanium materials compared to their conventionally manufactured counterparts.¹ While the LCAs modeled several categories, energy usage and carbon emissions best illustrate how UniMelt significantly reduces the environmental impacts of metal additive manufacturing.

UniMelt nickel (Ni) production process reduced carbon emissions and energy consumption by more than 91% compared to traditional nickel production (figure 7):

¹ Foresight Management, February 2022

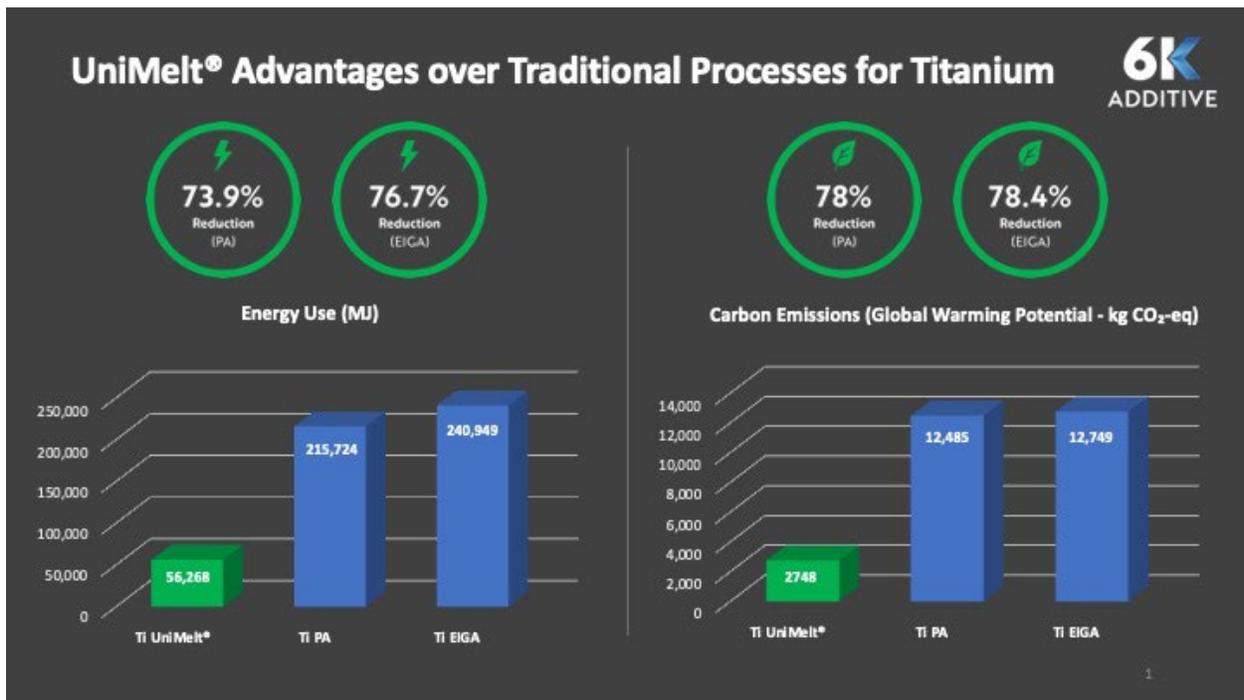
Figure 7. LCA Results for Nickel Production with UniMelt over Traditional Process



Source: 6K Additive

UniMelt titanium (Ti) production process reduced carbon emissions and energy consumption compared to conventional titanium production by more than 73% (figure 8):

Figure 8. LCA Results for Titanium Production with UniMelt over Traditional Process



Source: 6K Additive

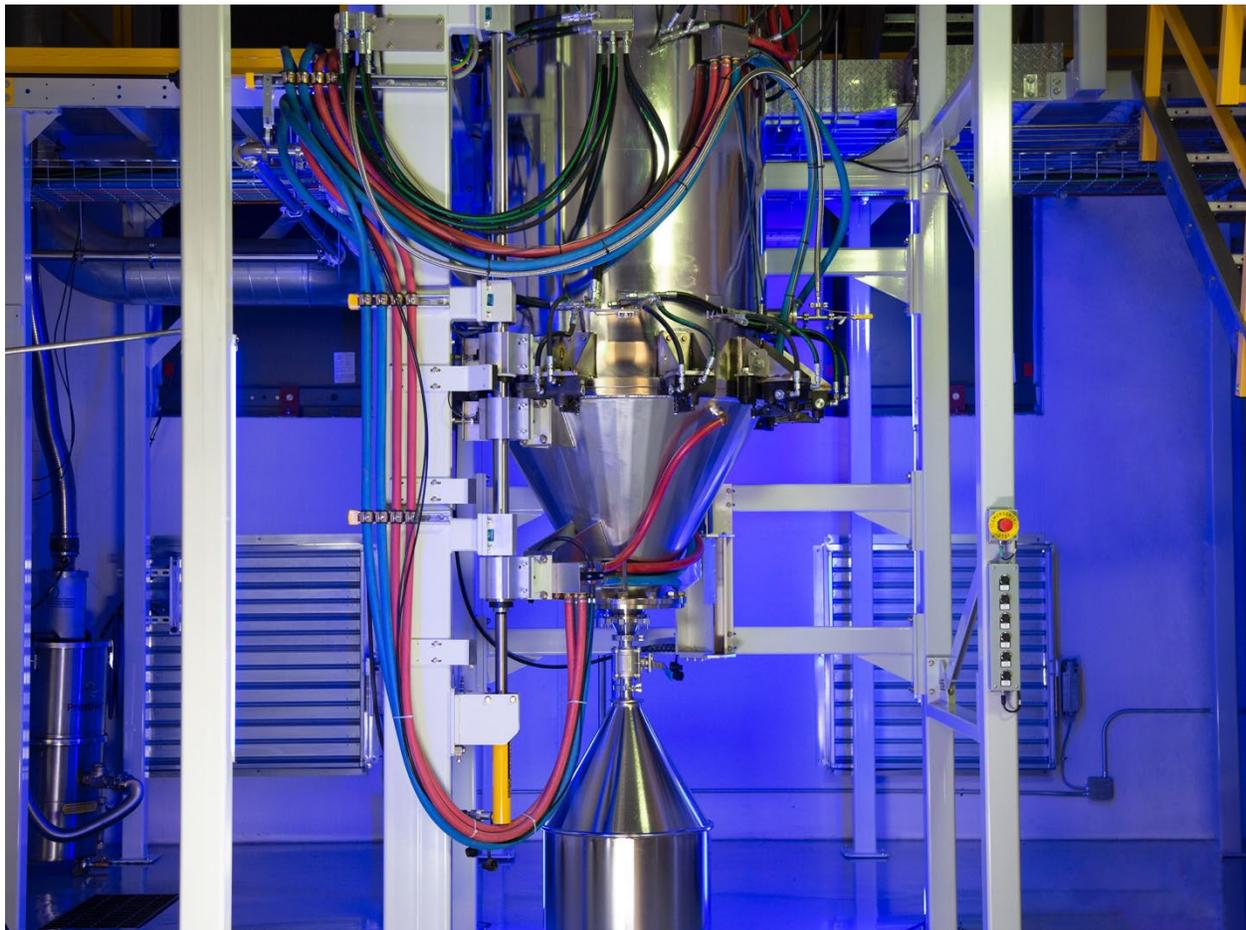
6K Additive manages the entire AM scrap stream, including condensate, parts, and supports. Moreover, UniMelt not only recycles waste material and puts it back into the supply chain but also produces less waste. The LCAs provide the evidence required to support decisions that balance a sustainable future without hurting your metal AM parts' performance, quality, or cost.

Advice

How do you achieve ambitious environmental targets, produce quality AM parts, and remain competitive?

Understanding the expensive life-cycle cost of conventional AM powder manufacturing compared to UniMelt is the first step toward creating an authentic, sustainable circular economy. 6K Additive's technology proves the cradle-to-cradle cost of sustainability can be financially competitive, positively impact performance and quality, and open new markets and applications. With 6K Additive, you and your customers finally have the high-quality, production-grade advanced materials that enhance applications and are cost-effective and sustainable.

Figure 9. UniMelt Microwave Plasma Production Platform



Source: 6K Additive

Disclaimer

All specifications and features are accurate as of the report's publication date. Visit [6K Additive](#) for current additive manufacturing specifications and features.

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