New Life For Bell's Cobra

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New industrial-scale 3-D-printing venture targets Boeing, Lockheed work

Graham Warwick **Washington**

NTI's wire-based plasma process produces titanium parts that require less material and machining.

In a bold move to bring industrial-scale 3-D printing to the aerospace supply chain, Norway's Norsk Titanium (NTI) is partnering with a U.S. state to establish a facility to produce aircraft and engine components using additive manufacturing (AM).

NTI has developed a plasma-arc-based direct metal deposition technology that can produce aerospace-grade parts from titanium wire. The U.S. manufacturing facility, which will be built and owned by the state government and leased and operated by NTI, will be able to produce 1,000 tons (2 million lb.) of titanium parts a year by 2018, says President and CEO Warren Boley.

"What 3-D printing technology enables us to do is to take legacy titanium products with 55-75-week lead times and buy-to-fly ratios of 10-20 to 1, take the CAD [computer-aided design] file and print a 20-lb. part in 2 hr.," he says. "The printed part has equivalent mechanical properties—in fact, the fracture toughness and crack-growth performance is elevated, which is a future design opportunity."

A Boeing 787 demonstration component shows (left to right) the part as printed, then the two machining steps required to produce the finished item.

With high strength and light weight, titanium is increasingly used in aerospace, but the weight ratio of raw material to finished product can be high and machining is expensive. By printing near-net parts that require less material and machining, "we can eliminate 50-75% of the cost," says Boley. NTI has provided pricing to manufacturers and is producing parts for testing, he says.

NTI estimates there are 1,000 titanium parts in a Boeing 787 that can be printed using its process. "We are already providing Boeing with pricing data. We think we can save $2,500 per part; that's $2.5 million per aircraft. At 144 aircraft a year, that's $360 million. That kind of saving is revolutionary," he says.

Savings come from "how much material goes in and how much is machined off," says Boley. "You can take a 200-lb. forging and produce a 20-lb. part. We can print 30 lb. of material to produce a 20-lb. part." Components produced require only finish machining. "It is the ultimate in lean manufacturing—wire to finished part in 150 ft.," says Chet Fuller, NTI's chief commercial officer.

While the use of additive manufacturing by the aerospace industry is growing, announcement of the location of the "government-owned, contractor-operated" (GoCo) facility in the next few weeks will "supercharge the technology," Boley says. The unnamed U.S. state will build the facility and equip it with NTI's direct metal deposition machines, then lease it to the company at an "attractive price," he says.

"This is the closest thing to a Silicon Valley startup in aerospace. The GoCo partnership allows rapid introduction into commercial and defense customers, where titanium is an increasingly important aspect of their business," says Boley. "We are also talking to Lockheed Martin. There is a product and industrial cooperation opportunity, as Norway is an F-35 [Joint Strike Fighter] partner."

NTI has completed material and process qualification testing, producing 1,800 test coupons, and is submitting the data to manufacturers and the FAA for certification. "We are now into part demonstration and qualification at the specific part-number level. Manufacturers are clearly saying this is an equivalent titanium product. Now we need final approval before we can deliver parts," he says.

Boley expects to start receiving orders in first-quarter 2016, for delivery of flyable components in the second quarter. The U.S. facility is planned to be operational by the end of 2016. To meet customer certification and delivery dates, and provide a schedule buffer, NTI is adding four production machines to its test center in Norway.

In the initial phase, the U.S. plant will ramp up to 50 machines, but the facility will be able to accommodate up to 100 machines, with the capacity to produce 2,000 tons of titanium components annually. Boley says NTI's wire-fed plasma process lends itself to industrial scaling more easily than additive-manufacturing technologies using lasers or electron beams and requiring vacuum processing.

NTI's machine has a 1,000 X 500 X 300-mm (40 X 20 X 12-in.) working volume, similar to conventional machining centers used by aircraft manufacturers. Where additively manufactured components are usually compared with castings in terms of performance, Boley says parts produced are like forgings. The argon environment used allows for heating, cooling and quenching to enhance material properties versus vacuum processing, he says.

The process technology also allows the material microstructure to be tuned, so that fracture toughness can be elevated at the cost of tensile strength. In parts designed to damage-tolerance requirements, some parts leave the factory with a crack, the process can improve crack-growth resistance, Boley says.