

Titanium: It's Not Just For Golfers Anymore

Sector:	Motorsports
Technology:	SLS® system

Minardi Formula 1 Team races to finish line with titanium parts investment cast from CastForm™ patterns

Using titanium to gain a competitive edge is part of the strategy for Italy's Minardi Formula 1 race team.

The latest Minardi Formula 1 (F1) race car features several new high performance titanium components. These parts were investment cast in titanium and other metals from patterns made by the team's technical sponsor, C.R.P. Technology of Modena, Italy. C.R.P.'s pattern-making secret? Using its in-house SLS® systems and 3D Systems' CastForm™ material.

The Fast Track To High Performance

C.R.P., a division of the Cevolini Group, used SLS systems to rapidly produce the CastForm PS patterns for the uprights, suspension supports, clutch box, steering box, and gear box for the Minardi F1 car. These rapidly produced patterns were then shipped to CoastCast Corporation, a foundry in Rancho Dominguez, California. Here they were investment cast in a modified version of Ti 6246.

Within five to eight weeks (part dependent) the titanium parts were cast, machined, tested, and installed on the Minardi F1 car in time for the 1999 championships. These races take place all over the world in places such as Australia, Japan, and Canada, and at numerous sites across Europe.

"Formula 1 racing is a very difficult, technically demanding field," says Franco Zucchelli, Marketing Manager for C.R.P. "These teams are willing to try anything to get the results they want, and the Minardi team was willing to try what no other team had tried before."

Parts With A Purpose

Among the most critical parts for the Minardi F1 car were the uprights, the four parts that hold together the upper and lower wishbone of the wheels. This is an important part of the car; the area where the suspension comes together. The uprights hold and support the caliper for the brakes, as well as the hubs of the wheels.

These "out-of-fender" parts have to be strong because they are directly in touch with the ground through the wheels. Imagine the abuse these parts have to take on a car that races at speeds of up to 320 Km/h.

"The uprights are very sensitive parts in the geometry of the suspension and have to be very strong and stiff, yet very light," Zucchelli explains. "It is really hard to combine all these characteristics. To do this we had to design a very complex and intricate geometry and use the titanium."

"With CastForm material we are able to cast some very sophisticated designs in exotic metals and at a much less expensive price than could ever be attained through machining or fabrication. What's more, the cast parts are stronger."

*Bryan Rolfe, Vice President of New Product Development
CoastCast, Rancho Dominguez, CA, USA*

Designed With The Process In Mind

So what's the strategy behind designing such a critical part in such a temperamental metal? "We designed the pattern for the uprights and some of the other parts knowing they would be patterned on our SLS system," Zucchelli adds. "There were a lot of undercuts, hollow areas, dropped angles, and other features that would have been difficult to create via tooling." These features and details are easily created with the layer-by-layer SLS process.

As the C.R.P. staff worked to develop the uprights, they knew that creating the patterns with 3D Systems' CastForm PS material and the SLS process would offer even more advantages. The process would save them time and the CastForm PS patterns would work well with reactive alloys, including the modified Ti 6246.



Casting The Titanium Parts

The Minardi team needed ten sets of four uprights for a total of 40 parts. (A larger race team might need 15 to 20 sets or a total of 60 to 80 parts.) Several other parts for the car were also cast at CoastCast at this time. "We actually had the uprights cast in both Ti 6246 modified and Steel 17-4PH, just to compare the two," explains Zucchelli. "The steel is a relatively high strength alloy that would have worked well also, but it is heavier than the titanium."

CoastCast also cast the steering box in the modified Ti 6246 and a variety of other alloys, such as Al 206. The clutch box and suspension supports were cast only in the modified Ti 6246. The Al 206 and the Ti 6246 are both light, but the titanium offers more strength where it's needed most. Creating the parts via investment casting, as opposed to machining them, was economically and technically advantageous, say C.R.P. staff members. They also note that both C.R.P. and CoastCast are continually learning more about CastForm PS material and the intricacies of creating titanium parts this way.

The Results

One lesson C.R.P. and CoastCast learned: the new titanium parts are a big improvement over those used on the previous year's Minardi F1 car. "The parts were very good," Zucchelli says. "They were extensively tested and passed each test with flying colors." The parts were part of the Minardi F1 car for every race in 1999. They even survived several mishaps, including one that destroyed the wheels on the car. "There wasn't so much as a deformity," notes Zucchelli. "These parts are much lighter, yet stronger." And, unlike the machined and welded versions used on other cars, the one-piece upright design requires virtually no maintenance. "They are checked after each race out of principle," says Zucchelli, "but the maintenance crew has never had to do any repair or rework on them at all."

The Benefits

TIME SAVINGS.

"Using our SLS system and the CastForm material to create the patterns saves us a considerable amount of time," says Zucchelli. "That's one of the primary reasons we use it. You can go from CAD design to casting and to the finished part in six to eight weeks. Normally it would take at least ten weeks just to make the tool, plus it might take an additional six weeks for the rest of the process. We essentially cut our time in half."

CHANGES MADE EASILY AND OFTEN.

In addition, C.R.P. and Minardi could make design changes throughout the process without endangering project costs or missing fast-paced deadlines. In fact, C.R.P. and Minardi made six design changes to the rear upright for the Minardi car. "Changes such as these would have been practically impossible to make with traditional tooling," says Zucchelli. "Even if you could manage to design it in time, it would be prohibitively expensive."

SIGNIFICANT COST AVOIDANCE.

This brings up cost issues. Tools for the four uprights could cost about 25,000 to 50,000 US\$. A more complex design could go as high as 50,000 to 75,000 US\$ for the four tools. "And, it would take a lot of soluble waxes and a lot of ceramic cores," notes Zucchelli. "It would be a very complex design." Zucchelli adds, "Another option, machining the part in titanium, would be forbiddingly expensive as well. With the casting method we used, you only need a relatively small amount of material and even then it is practically impossible to acquire and very expensive."

NO WELDED JOINTS.

Earlier we mentioned that the titanium parts could be cast in one piece with no major welds or joints. "Our experience tells us that this type of part is better performing," confirms Zucchelli. "Machining and welding parts is very tricky. It requires a lot of destructive testing to ensure that the part is up to standards. Plus, it requires a lot of rework during the life cycle of the part. With these titanium parts, there is no need for rework at all, even after thousands of miles."

MORE METAL CHOICES.

With the SLS/CastForm formula, C.R.P. also had the freedom to cast parts in the alloy of choice.

FOUNDRY APPROVED.

Even foundries agree that CastForm PS material works very well in investment casting, even with sensitive metals such as titanium. "Our foundry is very happy with the CastForm material," says Zucchelli. "They don't find any problems with it, so that is an important feature of this material."



26081 Avenue Hall • Valencia, CA 91355 USA
telephone 661.295.5600 • fax 661.294.8406
toll-free 888.337.9786 • email moreinfo@3dsystems.com