RSP TOOLING

Technology under development at the Idaho National Engineering & Environmental Laboratory, termed **Rapid Solidification Process (RSP) Tooling**, provides an alternative approach for making molds, dies, and related tooling that could potentially reduce their cost and lead time by a factor of 5 to 10.

RSP Tooling is the recipient of a 1998 R&D 100 award for technological innovation. The award, given annually by R&D Magazine, is one of three that INEEL researchers received this year. According to R&D Magazine, the awards are given for "products that are so interesting, unusual, or clearly superior to existing technology that they make you say "Wow!". These products join the ranks of such lifestyle-enhancing inventions as the automated teller machine, anti-lock brakes, and the fax machine.

A polyethylene child's toy (left) served as the pattern for this spray-formed, tin-copper alloy die.

Kevin McHugh exhibits the supersonic rocket and the die made by RSP Tooling Process.

A Souped-Up Paint Sprayer

Nearly all mass-produced items require precision molds or dies for their formation. Manufacturers from carmakers to toy companies are always looking for ways to make dies quickly and cheaply.

The process involves atomizing a bulk liquid metal tooling alloy and directing the spray onto three-dimensional patterns made from plastic, wax, castable ceramics or other easy-to-form materials. As the deposit builds up, it faithfully replicates the shape, surface texture and surface detail of the pattern. The approach is compatible with rapid prototyping or solid freeform fabrication techniques, such as stereolithography, fused deposition modeling, laminated object manufacturing, and selective laser sintering, that can produce tool patterns or desired part shapes directly from CAD drawings. A 4" x 4" x 1" insert can be sprayed in about four minutes using a bench-scale system.

The conventional method for making specialized, custom tooling, such as injection molds and dies, involves multiple machining, grinding, polishing and heat treatment steps. The rapid solidification process circumvents the majority of these steps.

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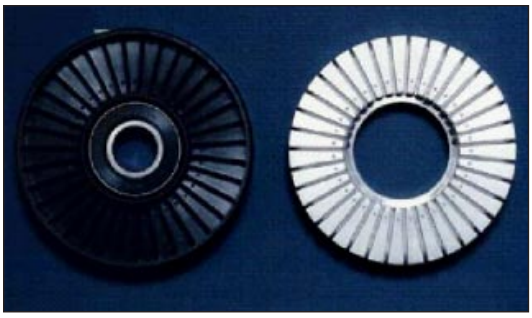
During atomization, the surface area of the metal increases about ten orders of magnitude. Consequently, heat is extracted by convection very rapidly, resulting in a combination of liquid, solid, and slushy droplets. The unusually high cooling rate results in rapidly solidified products that can offer property improvements, such as refined microstructure, extended solid solubility, and reduced macrosegregation, compared to cast materials.



The die (right) was created out of P20 tool steel on a ceramic pattern made form the plastic engine pulley form on the left.

New Process, New Problems

Compared to conventional fabrication methods, RSP Tooling reduces cost and turn-around time for production of precision tooling by a factor of 5 to 10. Currently, the bench-scale system can produce molds up to about 4 inches square, but the INEEL plans to scale up to 12 inches during the coming year. This covers about 70% of the manufacturing industry's requirements.

But the true test of how best to take advantage of RSP is by putting the tooling to work under the circumstances in which they'll be used. "You learn what conditions give the best material properties and replication details," McHugh says. Manufacturing companies are already lining up to take advantage of RSP Tooling's speed and low cost.

Manufactures might not be ready for RSP's level of replication detail, however. RSP can reproduce fingerprints accidentally left on a glass mold. That level of precision causes new problems for diemakers. "Now we need to make better mold ceramics," McHugh says, "because we're picking up all the imperfections on the molds."

With D2 steel alloy (left), RSP Tooling precisely recreated the raised letters on the ceramic mold (right).

For more information about RSP Tooling, contact Advisory Engineer and Scientist Kevin McHugh (208) 525-5713 or Paul Grahovac (208) 526-348 at the INEEL's Technology Transfer Office.