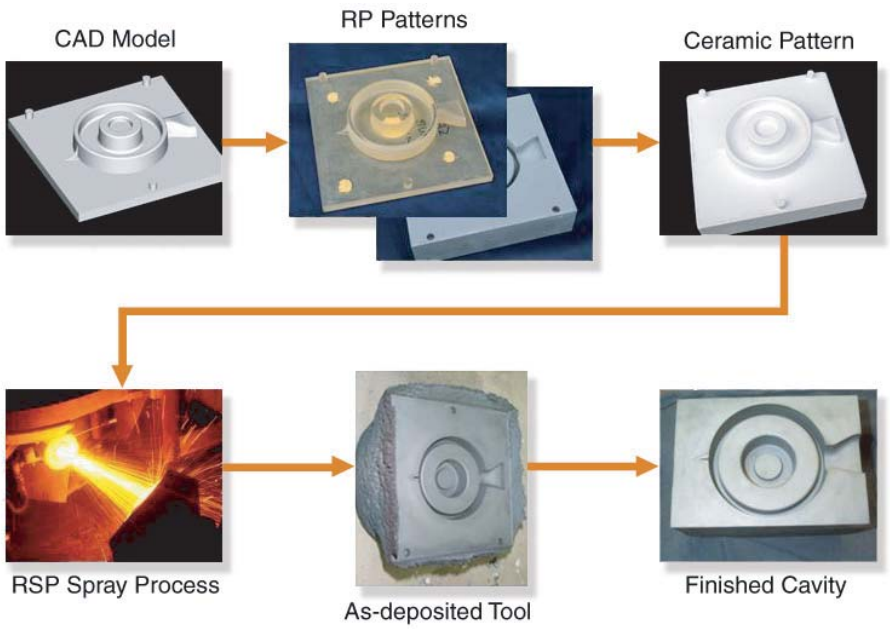
Industrial Technologies Program

Advanced Tooling Alloys for Molds and Dies Developed and Demonstrated

Improvement Over Conventional Tool Steels in High Temperature Strength, Wear Resistance, Toughness, and Thermal Fatigue Resistance

Molds, tools, and dies are required for the formation and production of nearly all mass-produced items, spanning diverse industries such as glass, metal casting, steel, forging, heat treating, aerospace, automotive, medical and power generation. Manufacturers, from car makers to toy companies, are always striving to make molds, tools, and dies more quickly and economically. Conventional machining methods are time consuming and expensive due to the required accuracy and tolerances. Rapid Prototyping (RP), Rapid Solidification Processing (RSP) and new tool alloys can now be integrated into a simple process to produce molds and dies more efficiently. The improved microstructure from RSP and the use of new alloys result in longer tool life which leads to energy and cost savings. This project developed new RSP tools and has demonstrated their use in improving manufacturing productivity while reducing energy consumption and scrap.



RSP Tooling Process Steps

Benefits for Our Industry and Our Nation

- *Industrial energy savings:*
  0.14 TBtu/yr by 2010
  5.56 TBtu/yr by 2020
- *20-25 % time savings over conventional die making*
- *22-33 % reduction in die/tool/mold manufacturing costs*

Applications in Our Nation's Industry

This project was a broad-based effort to develop and transfer technology over a wide range of possible applications for RSP Tooling. The project will benefit the following industries:

- Glass
- Metal Casting
- Steel
- Forging Industry
- Heat Treating
- And the manufacturing industries that utilize their products

Project Description

This project focused on the development and demonstration of a new class of mold and die tool steels tailored for Rapid Solidification Processing (RSP) such as spray forming. Improvements in high temperature strength, wear resistance, toughness, thermal fatigue resistance, and other properties over conventional tool steels were demonstrated. Production runs were conducted by industry to demonstrate the longer service life of the new die materials.

Barriers

Conventional fabrication of molds and dies is very expensive and time consuming. The reasons are: (1) each is custom made to the desired geometry, (2) mold and die materials are difficult to machine and work with, and (3) the dies must have high dimensional accuracy.

Pathways

The project pathways to successfully develop new materials and techniques for RSP Tooling were as follows:

- Analyze conventional ferritic tool steel samples produced by RSP and subsequent thermal treatments.
- Use modeling to develop an understanding of the relationships between the spray characteristics and tool formation.
- Develop modified alloys based on the microstructure/property relationships determined from artificial aging studies.
- Modify spray forming equipment to optimize performance.
- Prepare RSP-formed tooling inserts using the modified tooling alloy composition and send to industry partners for testing and analysis.

Results

- Extended die life by 25% as a result of unique microstructural qualities found in rapidly solidified tool steel and developed tool steel alloys tailored to the process. Anticipated energy savings is 0.27 TBtu/yr by 2020.
- Reduced the energy associated with tool steel production. Anticipated energy savings is 2.81 TBtu/yr by 2020.
- Eliminated many of the machining, grinding, and benching unit operations necessary to transform the tool steels into molds and dies for die casting, forging, stamping and glass manufacture. Anticipated energy savings is 0.80 TBtu/yr by 2020.
- Provided a means to heat treat the tool steel using relatively low temperature artificial aging rather than conventional austenitization/quench/temper heat treatment. Anticipated energy savings is 1.68 TBtu/yr by 2020.
- "Rapid Solidificaton Processing System for Producing Molds, Dies, and Related Tooling", United States Patent Number 6,746,225 issued June 8, 2004.
- RSP Tooling Technology selected for an *R&D 100 Award* in 1998.

Commercialization

RSP Tooling, LLC in Solon, Ohio was established in January 2002 with the goal to commercialize the RSP technology developed at Idaho National Laboratory (INL). Their strategy was to find corporation partners who were active stakeholders in the tooling industry, not just investors. Start-up funding for RSP Tooling, LLC was raised and a field-of-use license agreement was negotiated with INL. A beta RSP Tooling machine was built and is being used to develop and understand the spray deposition parameters of various alloys. This system is also being used to manufacture dies and molds for commercial testing and use.

Project Reports

This project was completed in September, 2005. The final report is in preparation and will be placed on the Industrial Technologies Program web site: http://www.eere.energy.gov/industry/imf/completed_rd.html.

Project Partners

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A Strong Energy Portfolio for a Strong America

Energy efficiency and clean, renewable energy will mean a stronger economy, a cleaner environment, and greater energy independence for America. Working with a wide array of state, community, industry, and university partners, the U.S. Department of Energy's Office of Energy Efficiency and Renewable Energy invests in a diverse portfolio of energy technologies.

U.S. Department of Energy
Energy Efficiency and Renewable Energy

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