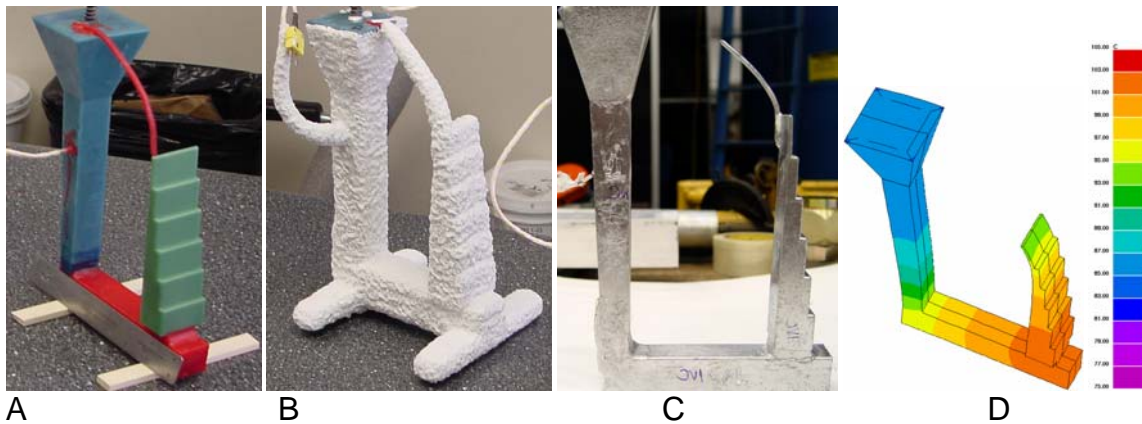


Improved Dimensioning Practices Increase Productivity and Savings in the Investment Casting Process

Oak Ridge National Laboratory's (ORNL) Materials Science and Technology Division has validated procedures to obtain material properties for predicting pattern tooling and casting dimensions for the investment casting process. The process consists of 1) making wax patterns by injecting wax into metal dies, 2) building a ceramic shell around the wax patterns, 3) dewaxing the ceramic shell molds, 4) and then casting alloys in the shell molds. Dimensional changes between the pattern tooling and its corresponding cast part occur as a result of deformation of wax, shell, and alloy materials. It was demonstrated for plant trials that (a) thermo-mechanical properties of waxes can be measured (b) accurate heat transfer conditions at mold surfaces can be evaluated based on first-principle theories, (c) the alloy shrinkage factors were successfully predicted based on computer simulations by taking into account the thermomechanical properties of the alloy and shell mold materials. New testing guidelines for waxes were presented to the Investment Casting Institute. As a result of this work, ProCAST™, a leading casting simulation software, implemented a viscoelastic module that is currently being validated. ORNL methodologies allow the prediction of dimensions and enhance the use of currently-used casting simulation software by eliminating the guesswork in conducting numerical simulations. The deployment and application of this technology will reduce trial-and-error runs in the casting design process, increasing productivity and reducing costs. It is estimated that an increase in yield from 55% to 65% and a reduction of scrap from 4% to 3% could yield a total energy savings of 7.6×10^{11} BTU/year in the production of steel, titanium, and aluminum castings.



Investment casting process: (a) wax pattern, (b) shell mold, (c) casting in the shell mold, and (d) aluminum casting (d) temperature distribution and casting distortion. Deformation was magnified 15 times.

ORNL has partnered in this DOE ITP-sponsored research with Schrey & Sons Mold Company, Inc. of Valencia, CA; Buycastings.com of Dayton, OH; Precision Metalsmiths, Inc. of Cleveland, OH; J&J, A DePuy Company of Raynham, MA; Precision Colloids, LL of Cartersville, GA; Minco, Inc. of Midway, TN; JEM

Manufacturing of Long Lake, MN; S&A Consulting Group, LLP of Cleveland OH; M. Argueso & Company of Mamaroneck, New York; Precision Castings of Tennessee, Inc. of Gallatin, TN; Edison Materials Technology of Dayton, OH, and ESI North America, MI. *Contact: Ron Ott, 574-5172, ottr@ornl.gov.*