

Research Programs

Cost Effective Densification of Critical-Application Aluminum Castings through Simultaneous Hot Isostatic Pressing and Solution Heat Treatment

Research Team:

Matthew M. Diem
Richard D. Sisson (WPI)
Stephen J. Mashl (Bodycote NA, Inc.)

Cast aluminum components are seeing increased use in applications where resistance to fatigue failure is required. The elimination of inherent porosity in aluminum castings through Hot Isostatic Pressing (HIP) is paramount in the production of these fatigue-resistant components. Solution heat treatment is also required to attain necessary tensile properties from the alloy.

The Densal® process is a Bodycote proprietary HIP process tailored specifically to aluminum castings. Densal® represents an improvement in cost-effective densification of aluminum castings, however, Densal® is currently an independent process from heat treatment, and thus, costs in both time and energy are incurred from its use.

Due to similarities of the processing temperatures in Densal® and solution heat treatment, these processes could be combined to attain greater process efficiency. However, inherent heat- and material-transfer issues require resolution before a combined industrial process can successfully be implemented. The quantification of mechanical properties that result from a combined process is also required.

Objectives

- Investigate the feasibility of combining the two independent processes of Hot Isostatic Pressing (HIP) and solutionizing heat treatment into a single, cost-effective procedure of producing castings for critical applications. This will be accomplished via theoretical and experimental means. A computer model of the thermal response of castings in a HIP unit is being developed. The model will be used to characterize energy consumption and thermal history of processed material as well as evaluate various processing options. Experimentally, we will compare the material properties and microstructure of castings subjected to a combined process to those subjected to the autonomous processes.
- Incorporate existing theories of homogenization and precipitation in A356 will be correlated to the practice of a combined manufacturing process.
- A final goal is to begin the design and implementation of a production scale operation.