TECHBRIEF

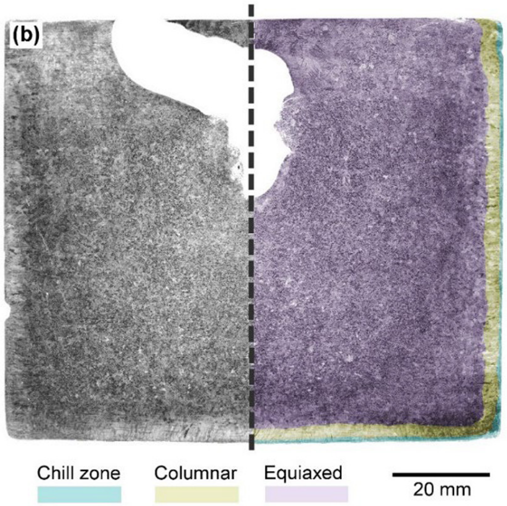
CREEP RESISTANT NI-BASED SUPERALLOY CASTING AND MANUFACTURING

OPPORTUNITY:

This invention describes an improved casting and manufacturing method for a creep-resistant nickel-based superalloy for advanced high-temperature applications. This technology is available for licensing and/or further collaborative research from the U.S. Department of Energy's National Energy Technology Laboratory.

CHALLENGE:

In the future, advanced ultra-supercritical (A-USC) and/or supercritical carbon dioxide (sCO_2) power plants are expected to raise efficiencies of coal-fired power plants from around 35 to greater than 50%. However, these advanced systems feature components that operate at high pressures and temperatures exceeding 760 degrees Celsius. These conditions cause gradual permanent deformation, known as creep, in components manufactured with currently used alloys like ferritic-martensitic high-strength steels and austenitic stainless steels.



Certain nickel-based super alloys such as Inconel 740H (IN740H) currently meet requirements for use in A-USC in a wrought version, but using the alloy in a cast form would be valuable in terms of the range of component size, geometries and complexities, and cost.

Previous efforts at casting IN740H have resulted in poor creep performance when compared to wrought versions. Furthermore, several compositions within the nominal specified range for IN740H have been investigated but failed to provide a material in the as-cast form that would withstand long-term, high temperature exposure in creep.

OVERVIEW:

This invention proposes an alternative casting approach called the Fine Grain Homogenized (FGH) approach, which enables the use of a nickel-based superalloy that is nominally based on IN740H to cast articles in A-USC and sCO_2 power plants.

The FGH approach is derived from methods known as fine-grain casting, which employ a low pouring temperature with pre-heated molds during the melting process to refine the grain size of the as-cast solidified article. In addition to the physical development of a fine-grain cast structure in the article from the melt-solidification approach, a computationally optimized homogenization technique specifically designed for the superalloys also used to ensure homogeneous chemical distribution of the hard to diffuse elements of the chemistry throughout the as-cast article.

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ADVANTAGES:

Results in a superalloy with:

- High strength.
- Long creep life.
- Good environmental resistance.

APPLICATIONS:

- Advanced ultra-supercritical power plants.
- Supercritical carbon dioxide power plants.
- Other high-temperature fossil energy power plant components, including boilers, steam turbines, valve chests, superheaters, headers, vanes, etc.

PATENT STATUS:

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