

## 1.9 Cladding and Freeform Deposition for Coolant Channel Close-Out

**Statement:** A robust and simplified manufacturing technology to build closed cooling channels and contain high-pressure coolant.

**Problem addressed:** Existing technology is complex in building closed cooling channel that requires time, expenses, and specialized tooling. Also, inspecting is difficult and not always reliable.

**Solution:** The new laser wire direct closeout capability reduces the time to fabricate the closed channel and allows for real-time inspection during the build. One variation enables a bimetallic part (copper/super-alloy, e.g.) to help optimize material where it is needed. The manufacturing process has been demonstrated on a series of different alloys.

**Technology description:** The new technology enables an improved channel wall with an outer liner that is fused to the inner liner to contain the coolant. The technology leverages wire freeform laser deposition to create features in place and to seal the coolant channels. It enables bimetallic components such as an internal copper liner with a super-alloy jacket. The process begins when a fabricated liner made from one material is clad with an interim that sets up the base structure for channel slotting. A robotic and wire-based fused additive welding system creates a freeform shell on the outside of the liner. Building up from the base, the rotating weld head spools a bead of wire, closing out the coolant channels as the laser traverses circumferentially around the slotted liner. This creates a joint at the interface of the two materials that is reliable and repeatable. The LWDC wire and laser process is continued for each layer until the slotted liner is fully closed out without the need for any filler internal to the coolant channels.

**Benefits of the product:** This technology provides a means to build heat exchangers more efficiently and cheaper. The technology is:

- Proven (via hot-fire testing) to produce a reliable bond with little deformation to the channels.
- Enabling bimetallic parts such as copper-Inconel and other alloy combinations.
- Applicable to many metals including: super-alloys, stainless steel alloys, aluminum-alloys, and bimetallic (including copper-based) alloys.
- Filler-free: no filler is needed in the cooling channels during fabrication.

The technology also:

- Allows real-time inspection with visible and infrared methods.
- Reduces build time from several months to several weeks.

**Areas of application:** The technology has multiple applications where cooling channels have difficult shape. It can serve many industries, including:

- Oil and Gas, refineries, paper and food industries.
- Fossil fuel and nuclear power.