Cast Heat Exchanger Using the Novel Al–Ce Alloy

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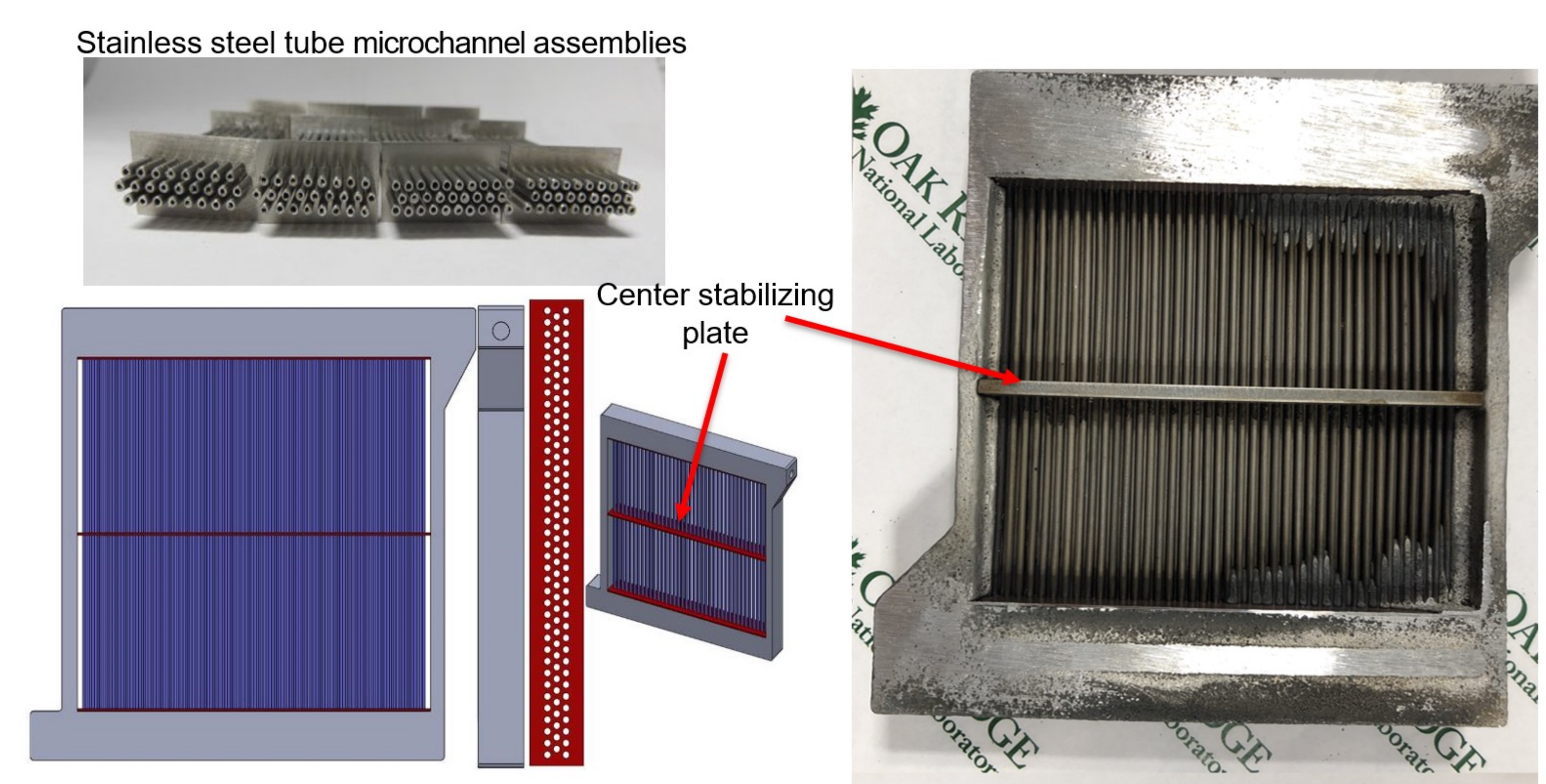
Research Challenge/Need/Problem Addressed

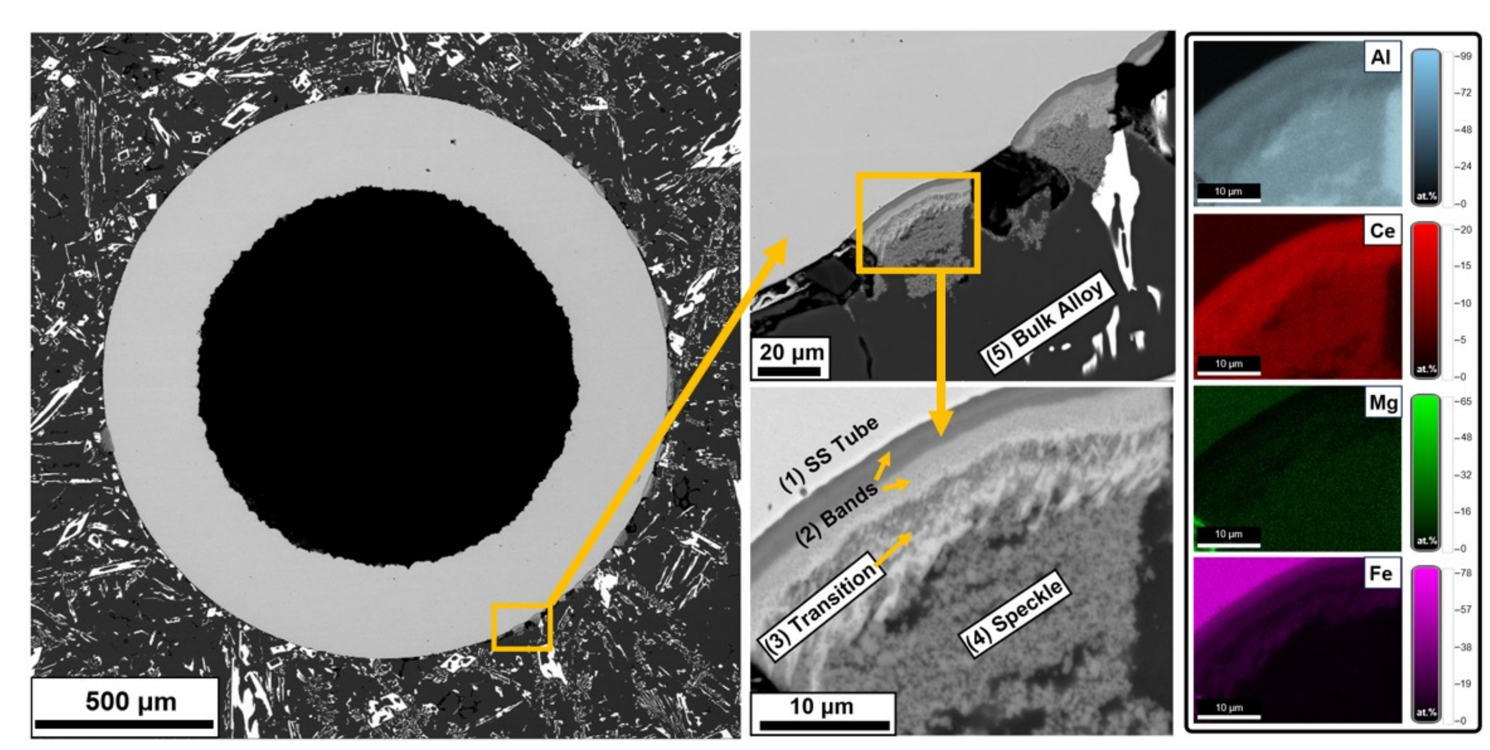
- The goal of this project, a collaboration between Oak Ridge National Laboratory and Eck Industries, is to develop a scaled-up, die-casted Al–Ce–Mg heat exchanger (HX) with excellent performance and 50% lower material cost than state-of-the-art condensing HXs used in commercial furnaces.
- Major objectives include evaluating the most critical properties relevant to the HX-casting process and HX operation, such as castability, engineered mold design, thermal conductivity, fluidity, and corrosion resistance.

Current Research

- The alloys studied for this project primarily comprise Al, Ce, and Mg.
- Alloys were formed by melting pure forms of the various elements.
- Samples were either as cast or extruded (ratios up to 52:1).
- The team demonstrated the ability to cast a full-scale HX with consistently spaced microchannels by adding a center stabilizing plate.
- Current efforts are focused on the following major aspects:
  - Effects of various alloy compositions on castability.
  - Development of a technique for single-step casting (headers and channels).
  - Demonstration of durability and corrosion resistance under realistic operation conditions.



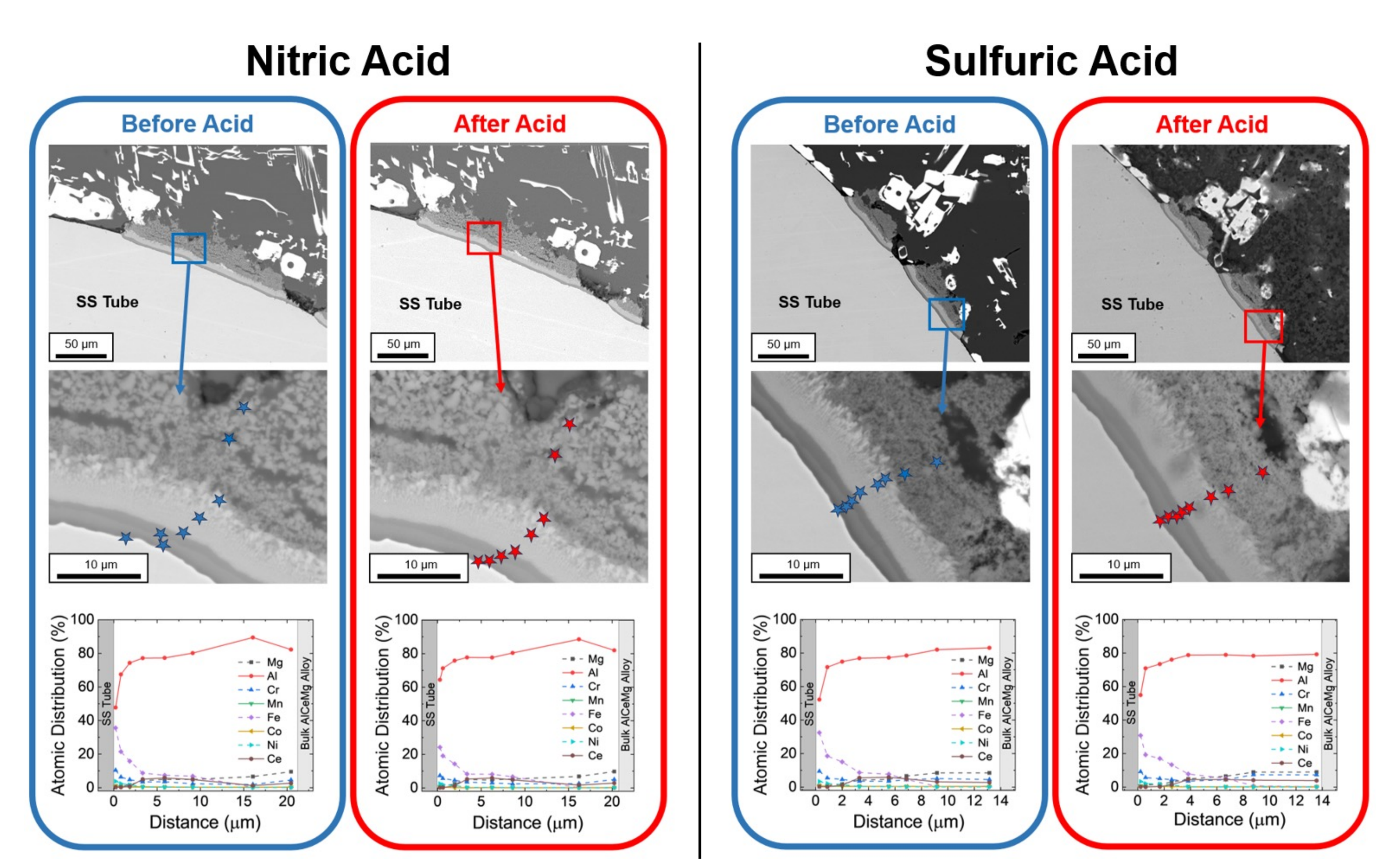
Development of microchannel HXs using center stabilizing plate



Analysis of bond between Al–Ce alloy and steel tubes

Major Impacts

- Castability reduced manufacturing cost:
  - No need for post heat treatment.
  - Optimized HX geometries.
- Castability resulted in a more reliable HX.
- Design had a customizable header that minimized refrigerant flow maldistribution.
  - Increased leak resistance.
- Alloy exhibited better corrosion resistance than Al alloys:
  - Resistance to deleterious effects caused by corrosive exhaust gases.
- Alloy displayed competitive mechanical strength:
  - High-pressure and high-temperature (~300˚C) applications.



No substantial changes to the compositional distribution or reactive bond morphology after exposure to 2 ppm nitric and sulfuric acid for 267 h.

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