

Expanding 3D Printing Capabilities: Thermally Stable Aluminum-Cerium Alloys

ORNL has recently developed novel cerium-containing aluminum alloys that offer weight, strength and temperature performance characteristics close to those of titanium-based alloys at a fraction of the cost. The high strength / high temperature characteristics of the alloys are due to the formation of ultra-fine nanostructures in the material when the alloy melt is rapidly cooled. Because additively manufactured (i.e. 3D printed) components are created by locally melting and rapidly cooling layers of material, the performance of these alloys is optimized in additive manufacturing processes. Furthermore, because the cooling rate of the alloy can be controlled during the additive manufacturing process, the strength / temperature characteristics of the material can be optimized locally within components as they are fabricated.

This project was accepted into TIP with the goal of enabling the adoption of low-cost, lightweight additively manufactured components in the automotive and aerospace industries where high strength at high temperatures is required. The increased strength of the alloy may allow the material to replace steel in some applications, and the combination of strength and thermal stability may allow the material to replace titanium in other applications.

Near term opportunities for the alloy include automotive heat exchangers and turbo charger impellers where the added design flexibility of additive manufacturing (e.g. complex internal cooling features impossible to manufacturing by traditional methods) may provide performance characteristics unavailable with traditional manufacturing processes.



Ryan Dehoff, PhD Physical Sciences Directorate

Dr. Ryan Dehoff is the Deposition Science and Technology Group Leader for Oak Ridge National Laboratory. He is developing processing techniques and exploring new materials via additive manufacturing to improve energy efficiency during component production, decrease material waste, and improve material performance. Projects include near net shape fabrication of titanium- and nickel-based super alloy components using low-cost feedstock materials and developing laser processing techniques for forming nanocomposite coatings and bulk components utilizing amorphous based powder materials.

Patent

High Temperature Al Alloys for Additive Manufacturing

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Inventors

Ryan Dehoff, Orlando Rios, and
Alex Plotkowski

ORNL Materials Science and Technology
Division, Deposition Science and Technology
Group

Niyanth Sridharan
University of Tennessee-Knoxville

Publications

- R.R. Dehoff, M.M. Kirka, W.J. Sames, H. Bilheux, A.S. Tremsin, L.E. Lowe, S.S. Babu, "Site specific control of crystallographic grain orientation through electron beam additive manufacturing". *Materials Science and Technology*.
- R.R. Dehoff, M.M. Kirka, F.A. List, K.A. Unocic, W.J. Sames. "Crystallographic texture engineering through novel melt strategies via electron beam melting". *Materials Science and Technology*.

For more information, please contact
Nestor Franco
Commercialization Manager
francone@ornl.gov
865-574-0534