Cyclic Oxidation Behavior of CuCrAl Cold-Sprayed Coatings for Reusable Launch Vehicles

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The next generation of reusable launch vehicles is likely to use GRCop-84 [Cu-8(at.%)-Cr-4(at.%)-Nb] copper alloy combustion liners. The application of protective coatings on GRCop-84 liners can minimize or eliminate many of the environmental problems experienced by uncoated liners and significantly extend their operational lives and lower operational cost. A newly developed Cu-23( wt.%)-Cr-5(at.%)-Al (CuCrAl) coating, shown to resist hydrogen attack and oxidation in an as-cast form, is currently being considered as a protective coating for GRCop-84. The coating was deposited on GRCop-84 substrates by the cold spray deposition technique, where the CuCrAl was procured as gas-atomized powders. Cyclic oxidation tests were conducted between 773 and 1,073 K to characterize the coated substrates.

The coating proved to be effective in preventing the cyclic oxidation of the substrate for up to 1,000 cycles. The coated substrates showed no significant weight loss in comparison to uncoated specimens, which lost between 60 to 80 percent of its original weight with much lower lives. The coating was adherent to the substrate at all temperatures, whereas the uncoated GRCop-84 showed excessive spallation of the oxide scale. It is anticipated that the use of this alloy can extend the operational life of the liner, which translates to increased component reliability, shorter depot maintenance turnaround time, and lower operational cost. Additionally, engines using CuCrAl-coated GRCop-84 combustion liners could operate at higher temperatures, thereby resulting in its increased thermal efficiency.

This work was done by Sai Raj of Glenn Research Center and J. Karthikeyan of ASB Industries. Further information is contained in a TSP (see page 1).

Inquiries concerning rights for the commercial use of this invention should be addressed to NASA Glenn Research Center, Innovative Partnerships Office, Attn: Steve Fedor, Mail Stop 4–8, 21000 Brookpark Road, Cleveland, Ohio 44135. Refer to LEW-18330-1.

Ceramic Fiber Structures for Cryogenic Load-Bearing Applications

Woven or braided fibers resist embrittlement under cryogenic conditions, enabling ultralow-temperature applications.

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This invention is intended for use as a load-bearing device under cryogenic temperatures and/or abrasive conditions (i.e., during missions to the Moon). The innovation consists of small-diameter, ceramic fibers that are woven or braided into devices like ropes, belts, tracks, or cables. The fibers can be formed from a variety of ceramic materials like silicon carbide, carbon, aluminosilicate, or aluminum oxide. The fiber architecture of the weave or braid is determined by both the fiber properties and the mechanical requirements of the application. A variety of weave or braid