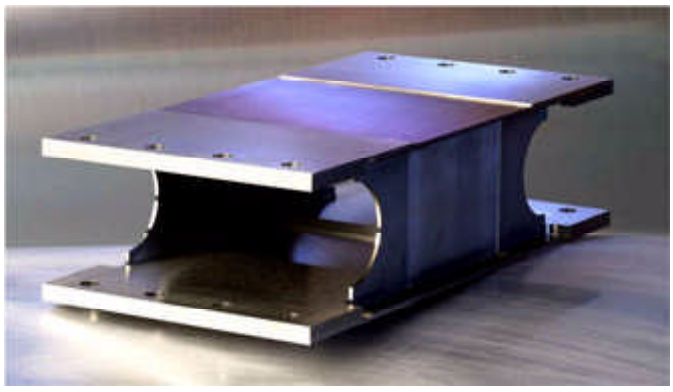
TiAl Scramjet Inlet Flap Subelement Designed and Fabricated

Next-generation launch vehicles are being designed with turbine-based combined cycle (TBCC) propulsion systems having very aggressive thrust/weight targets and long lives. Achievement of these goals requires advanced materials in a wide spectrum of components. TiAl has been identified as a potential backstructure material for maintainable composite panel heat exchangers (HEX) in the inlet, combustor, and nozzle section of a TBCC propulsion system. Weight reduction is the primary objective of this technology. Design tradeoff studies have assessed that a TiAl structure, utilizing a high-strength, high-temperature TiAl alloy called Gamma MET PX,[1] reduce weight by 41 to 48 percent in comparison to the baseline Inconel 718 configuration for the TBCC propulsion system inlet, combustor, and nozzle (ref. 1). A collaborative effort between the NASA Glenn Research Center, Pratt & Whitney, Engineering Evaluation & Design, PLANSEE AG (Austria), and the Austrian Space Agency was undertaken to design, manufacture, and validate a Gamma-MET PX TiAl structure for scramjet applications.

The TiAl inlet flap was designed with segmented flaps to improve manufacturability, to better control thermal distortion and thermal stresses, and to allow for maintainable HEX segments. The design philosophy was to avoid excessively complicated shapes, to minimize the number of stress concentrations, to keep the part sizes reasonable to match processing capabilities, and to avoid risky processes such as welding. The conceptual design used a standard HEX approach with a double-pass coolant concept for centrally located manifolds. The flowpath side was actively cooled, and an insulation package was placed on the external side to save weight. The inlet flap was analyzed structurally, and local high-stress regions were addressed with local reinforcements.



Gamma Met PX inlet flap subelement.

A Gamma MET PX subelement was designed to demonstrate full-scale manufacturing capability and to validate the design predictions and material properties. Three subelements were fabricated by one-pass brazing and were inspected by nondestructive evaluation with similar results. Brazes between the outer stiffener and the face sheet had good coverage, as did the majority of brazed joints. Subelement testing under anticipated

mission conditions is scheduled for fiscal year 2004.

Considerable progress has been made on the design, fabrication, and testing of Gamma MET PX sheet structures. Gamma MET PX structures offer considerable weight savings, and with careful design they can be implemented successfully in aerospace applications.

Reference

1. Collier, Craig: Vehicle Structural Optimization Study, Informal Program Review, NASA Contract NAS3-01138, Nov. 2002. Available from the NASA Center for AeroSpace Information.

[1]Gamma MET PX is a trademark of PLANSEE AG, Austria. Alloy composition is based on TNB alloys developed by GKSS Research Center, Germany.

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