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Title

Comparison of experimental Fatigue Life Study for two Inner Liner Materials for Liquid Rocket Engines

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Abstract

The paper on hand presents the comparison of two experimental fatigue life studies conducted with two copper alloys. The alloys are Cu-HCP and CuCrZr. Both materials can be used as the inner liner material for regeneratively cooled liquid rocket engines. The experimental aspect of this study uses Thermomechanical Fatigue (TMF) panels. A TMF panel represents a small section of a regeneratively cooled rocket combustion chamber. It typically consists of 7 cooling channels. The coolant being used is supercritical nitrogen instead of hydrogen or methane due to safety and cost concerns. The TMF test bench also incorporates a high power diode laser radiating onto the TMF panel surface. This provides realistic amounts of heat flux and surface temperature. The laser is cyclically powered on and off to represent the multiple load cycles that liquid rocket engines have to endure particularly in reusable rocket engines. This is procedure is repeated until the central cooling channel cracks. The setup of the TMF test bench provides data regarding the pure mechanical behavior of the material without the influences of any combustion or chemicals. Furthermore, heat flux, surface temperature and mass flow rate can be easily determined, hence providing precise input data for a numerical simulation and validation. The test conditions of both TMF panel test campaigns were a heat flux of $\dot{q} = 24.25$ MW/m² and a maximum surface temperature of $T_s = 800$ K. Data obtained in the test campaigns comprise fluid properties as well as mechanical behavior like displacement and strain on the laser loaded surface. The difference in the amount of laser power cycles defines the fatigue life behavior.

References

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