Orion EFT-1 Cavity Heating Tile Experiments and Environment Reconstruction

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Abstract

Developing aerothermodynamic environments for deep cavities, such as those produced by micrometeoroids and orbital debris impacts, poses a great challenge for engineers. In order to assess existing cavity heating models, two one-inch diameter cavities were flown on the Orion Multi-Purpose Crew Vehicle during Exploration Flight Test 1 (EFT1). These cavities were manufactured with depths of 1.0in and 1.4in, and they were both instrumented. Instrumentation included surface thermocouples upstream, downstream and within the cavities, and additional thermocouples at the TPS-structure interface. This paper will present the data obtained, and comparisons with computational predictions will be shown. Additionally, the development of a 3D material thermal model will be described, which will be used to account for the three-dimensionality of the problem when interpreting the data. Furthermore, using a multi-dimensional inverse heat conduction approach, a reconstruction of a time- and space-dependent flight heating distribution during EFT1 will be presented. Additional discussions will focus on instrumentation challenges and calibration techniques specific to these experiments. The analysis shown will highlight the accuracies and/or deficiencies of current computational techniques to model cavity flows during hypersonic re-entry.