Solar White Thermal Coating for Cryogenic Propulsion Systems

Jarred Wilhite1, Jason Wendell2

NASA Glenn Research Center, Cleveland, Ohio, 44135

**Abstract**

NASA is currently conducting research into the potential of storing cryogenic fluid in low Earth orbit (LEO). Having cryogenic propellant readily available for high-performance propulsion systems can be very beneficial for deep space missions in the near future. One of the key challenges to storing cryogenic fluid in LEO is minimizing boil-off. To address the challenge, NASA is evaluating new concepts in thermal insulation. One recent experimental study evaluated the feasibility of using Yttrium Oxide (Y2O3), formed into tiles or spray coating that can potentially be used as a thermal coating for cryogenic propellant storage applications in deep space. Due to its temperature and wavelength dependent optical properties, this “solar white” material can reflect a vast majority of the Sun’s radiative energy while having a very high infrared emissivity for rejecting heat to deep space.

As a part of the material development and proof of concept testing, multiple tests have been run at KSC and GRC to demonstrate the performance of the material. At GRC, the tests were run using the Deep Space Solar Simulator (DS3) which contains a thermal vacuum chamber in which the solar white sample was exposed to a deep space environment (< 10 K, optically dense walls) while under full illumination via solar lamp. In order to improve the use of the test results and apply them to spacecraft, there is a need to be able to model the material properties within NASA’s standard thermal modeling tools. As such, it was set out to verify a thermal model of one of the experiments using Thermal Desktop with Sinda. The thermal model of the DS3 test setup includes the solar white sample along with a solar lamp simulator capable of outputting heat at varying wavelengths. The model was developed in order to validate the test results and also to help predict results that will be obtained in future tests. This paper will review the modeling methods and thermal analysis results for various test cases that were run within the DS3 facility.