MATERIALS AND STRUCTURES SYMPOSIUM (C2)
Space Structures II - Development and Verification (Deployable and Dimensionally Stable Structures) (2)

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COMPARATIVE DEVELOPMENT OF DIMENSIONALLY STABLE STRUCTURES FOR THE DEPLOYABLE SUNSHIELD ASSEMBLY OF GAIA AND COMPOSITE TUBE ASSEMBLY OF SWARM

Abstract

GAIA and SWARM are european missions with launch date in 2012. GAIA's main objective is to map the stars. The satellite will always point away from the Sun allowing its telescopes to be kept at constant temperature. After launch, it will unfold a deployable sunshield assembly consisting of 12 composite trusses which act as scaffold to two multilayer insulation blankets. Due to thermal constraints the planarity of the 11 m diameter shield must be better than 0.1 mm.

SWARM is a multisatellite mission to explore the earth's magnetic field. To this end its main instrument is an ultrasensitive magnetometer bench incorporating both a scalar and a vectorial magnetometer. These are placed in a deployable conical tube of square cross section. The position tolerance of the vectorial magnetometer has to be fixed within 0.1 mm.

The main design driver of both structures is their thermal stability.

Although very different in geometry and materials the development and verification of both structures were performed concurrently by a single team using same production and testing facilities. The length of the structures exceeded 3.8 m and required use of a large precision measuring maschine to measure distortion under thermal gradients and in isothermal conditions.

The main cause for thermal distortion was the non-uniformity of the walls arising from the different adaptations of the filament winding process in order to manufacture the carbon fiber reinforced structural elements.

The manufacture of both structures required use of thermally controlled high precision bonding jigs to join the composite tubes to the metallic fittings.

This paper details:

- The material selection for the composite assemblies
- The modification of manufacturing process required to make the structures
- Their structural testing

- and their thermal stability testing and its correlation with prior predictions

emphasizing the lessons learnt during each step of the process. The paper highlights the use of low cost testing to verify thermal distortion as an alternative to the use of thermal vacuum chambers and laser measurement systems, which can be prohibitively expensive for large deployable units.

Both structures were qualified for their missions and the flight hardware has been delivered to the customer for system level tests.