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

Author: Mr. Ruven Spannagel
DLR, German Aerospace Center, Germany

Dr. Thilo Schuldt
DLR, German Aerospace Center, Germany
Mr. Martin Gohlke
DLR, German Aerospace Center, Germany
Dr. Jose Sanjuan
DLR, German Aerospace Center, Germany
Mr. Boris Messerschmidt
Airbus DS GmbH, Germany
Mr. Stefano Lucarelli
Airbus DS GmbH, Germany
Dr. Ulrich Johann
Airbus DS GmbH, Germany
Dr. Dennis Weise
Airbus DS GmbH, Germany
Prof. Claus Braxmaier
ZARM University of Bremen, Germany

CHARACTERIZING LIGHTWEIGHT AND DIMENSIONALLY ULTRA STABLE STRUCTURES FOR SPACE APPLICATION

Abstract

Lightweight and dimensionally ultra stable materials and structures are getting more and more important for spaced based applications. For scientific and earth observation missions, instruments with ultra high precision requiring ultra-stable structural materials are necessary to achieve the mission goals. Ultra stable glass ceramics have a very good behavior in terms of dimensional stability, but its huge mass is a disadvantage for space missions. Composite materials like CFRP (Carbone Fibre Reinforced Plastic) are lightweight and their CTE (coefficient of thermal expansion) is tunable to get low CTE at a specific temperature. On the other hand these composite materials are changing their geometry during time and environmental situations caused by moisture release and outgassing.

Structures, which combine the stiffness and lightweight properties of CFRP and the dimensional stability of Zerodur are a key technology for future space missions. Building such structures is one part of the challenge, the other part of the challenge is to determine the stability of such ultra stable structures.

Our focus is to measure the dimensional stability of lightweight and dimensionally stable structures for LISA/NGO and GRACE-FO. For LISA, we characterized an optical breadboard consisting of two 5mm thick Zerodur plates connected via a CFRP honeycomb structure leading to a weight reduction of 70%. For GRACE-FO the thermal stability of the triple mirror assembly of the laser ranging instrument consisting of a 0.5m CFRP spacer and Zerodur end-fittings on each side was characterized. For these measurements, a new facility was built.

To measure the CTE of the structures, a heterodyne interferometer is used to detect the expansion of the device under test. Two beams are reflected at two mirrors attached representatively to the samples

on each side. The noise level of our interferometer was demonstrated to be below $2\text{pm}/\sqrt(\text{Hz})$ ensuring an ultra-high accuracy of our measurements. The temperature is detected using PT100 sensors at the sample. Temperature changes are applied radiatively by a heating system in vacuum.

We present our new measurement facility, its characterization and first measurements of the thermal stability of the two structures for LISA/NGO and GRACE-FO.