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DIANA, A COMETARY DUST IN-SITU ANALYZER FOR TIANWEN-2 MISSION: THERMOMECHANICAL DESIGN

Abstract

The paper describes the development and testing of the DIANA (Dust In-situ ANAlyzer) thermogravimetric analyzer in the Tianwen-2 mission framework.Tianwen-2, led by China National Space Administration, is a sample return and comet exploring mission planned for retrieving asteroid samples from Kamo'oalewa 2016HO3 Near-Earth Asteroid (NEA) and for investigating the environment of 311P/PANSTARRS Main Belt Comet (MBC). Specifically, the mission is dedicated to the analysis of the chemical and physical composition of NEAs and to detect the presence of water in MBCs, enhancing the scientific understanding of their contribution to Earth's water delivery thanks to the D/H ratio analyses. The DIANA instrument is characterized by two advanced sensor heads — DIANA SH1 and DIANA SH2 — each crafted to reach different temperature working conditions; SH1 can measure up to 400 K, while SH2 has been designed to work up to 520 K. Each sensor head consists of a pair of Quartz Crystal Microbalances (QCMs), underpinned by a compliant mechanical system and an associated proximity electronic module capable of acquiring signals, as the beat frequency and temperature measurements. The crystals are integrated with an embedded heater for localized heating on the sensing element and a resistance temperature detector, which monitors the temperature along the sensing surfaces. This configuration enables the execution of thermogravimetric analysis (TGA), measuring in situ mass deposition as a function of time and/or temperature by the Sauerbrey principle and the Langmuir equation.

Thermomechanical design and integration of the instruments qualification models are described, along with the results of the performed preliminary environmental testing; both mechanical and thermal tests successfully satisfied the design requirements, guaranteeing the robustness of the thermo-mechanical design within the Tianwen-2 mission requirements. The positive outcomes of the work led to the manufacturing and preliminary integration of the Flight Models (FMs), currently ongoing.