IAF/IAA SPACE LIFE SCIENCES SYMPOSIUM (A1)
Advancements in Astrobiology and Space Exploration (6)

Author: Mr. Giacomo Colombatti
Università degli Studi di Padova, Italy

Dr. John Robert Brucato
INAF - Astrophysical Observatory of Arcetri, Italy
Mr. Alessio Aboudan
CISAS – "G. Colombo" Center of Studies and Activities for Space, University of Padova, Italy
Mr. Carlo Bettanini
CISAS – "G. Colombo" Center of Studies and Activities for Space, University of Padova, Italy
Dr. Francesca Ferri
Università degli Studi di Padova, Italy
Dr. Andrea Meneghin
Italy
Mr. Giovanni Valentini
Italian Space Agency (ASI), Italy
Ms. Francesca Ferranti
Italian Space Agency (ASI), Italy

VENOM (VENTURE THE EXTRACTION OF ORGANIC MOLECULES): PRELIMINARY DESIGN AND TESTS ON THE INSTRUMENT BREADBOARD

Abstract

Exploring molecular biosignatures is a key objective in international space exploration programs because these signatures provide more directly observable evidence of biogenicity compared to other types of biosignatures, where biological production is only inferred. The presence of these compounds on Solar System objects could serve as crucial evidence of actual habitability. Furthermore, identifying complex organic molecules may indi-cate traces of extinct life. Therefore, it becomes imperative to conduct in situ analysis using cutting-edge analyt-ical techniques to extract, concentrate, and detect organic molecules and molecular biosignatures.

Within the framework of activities supporting the development of scientific projects in the field of Astrobiology by the Italian Space Agency, the VENOM instrument goal is to create an innovative, miniaturized lab-on-a-chip breadboard that functions as a highly integrated, multiparametric, in situ platform. This platform will utilize immuno- and enzyme-assays to sensitively detect, identify, and assess biogenic compounds at parts-per-billion levels. The intended application involves analyzing samples extracted from the surfaces of planets or moons.

The instrument must receive samples from outer space while ensuring their containment within a sealed envi-ronment. Subsequently, the instrument is required to facilitate fluid treatment and incorporate specific lines for delivering the treated fluid to the detection system.

The device consists of three main components, with the first two currently undergoing testing in our laboratory:

- Sampling Module: Responsible for ingesting samples into the system.
- Microfluidic Network Module: Dedicated to handling liquid reagents throughout the system, this module performs tasks such as filtering and desalting the sample.

- Detection Module: Designed for detecting and quantifying the presence of biomarkers, this module utilizes magnetic microbeads to isolate biomolecules and employs chemiluminescence for their detection.

The VENOM instrument breadboard is designed to showcase a comprehensive and advanced capability for han-dling extraterrestrial samples, treating fluids, and precisely detecting biomarkers. The instrument is structured around a Main Frame that houses all its subsystems, with a baseline resembling the size of a 4U satellite.

This paper presents the status of the devolpment of the VENOM breadboard for technological demonstration and reports the preliminary activities carried out on the testing of the breadboard for the sampling module: spe-cific tests on the opening and closure of the ingesting valve and on the mixing of the sample with the relative solvent. Furthermore the testing of the microfluidic network shows that a trade-off on the selected valves and pumps has still to be evaluated.