IAF/IAA SPACE LIFE SCIENCES SYMPOSIUM (A1)
Medical Care for Humans in Space (3)

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APHRODITE: A LAB-ON-CHIP BIOSENSOR FOR CHEMILUMINESCENCE IMMUNODETECTION OF SALIVARY BIOMARKERS ONBOARD THE INTERNATIONAL SPACE STATION

Abstract

One of the main challenges for future manned deep space missions is to protect the health of the crew by setting up preventive methods, *in situ* and/or telemedicine diagnosis, and countermeasures against dysfunctions and diseases typical of long-duration spaceflight. The development of diagnostic tools suitable for biological fluid analyses during a Space mission is an active field of aerospace research. Miniaturized devices that take advantage of microfluidic approaches, such as lab-on-chips, are an ideal solution for application in Space, providing improved efficiency in terms of sample size, response time, cost, analytical performance, process control, integration, and automation. The APHRODITE analytical system, jointly developed by the Department of Chemistry "Giacomo Ciamician" of the University of Bologna, the School of Aerospace Engineering (SIA) of Sapienza University of Rome, and Kayser Italia S.r.l., and funded by the Italian Space Agency (ASI) in the VUS3:4ISSEXPLORATION programme, is designed to enable the detection of salivary biomarkers onboard the International Space Station (ISS). APHRODITE employs an integrated, easy-to-use, and portable analytical instrumentation (comprising a lab-on-chip with integrated thin film photosensors, a magnetic actuation subsystem, a fluidic actuation subsystem, a low-noise front-end electronic board, control and interface electronics, and a mechanical housing) with highly miniaturized accessories and microfluidics that permit automatic operation and reconfigurability to perform different analyses. The system also includes a series of disposable cartridges, each containing all the reagents required for an analytical run. Onboard the ISS, APHRODITE will be connected by USB port to an onboard laptop for power supply and for system protocol execution through a custom Java Graphic User Interface (GUI). The core of the APHRODITE system is a lab-on-chip device in which chemiluminescence (CL) immunoassays are performed on saliva samples to quantitatively detect cortisol and dehydroepiandrosterone sulphate (DHEA-S), chosen as biomarkers for stress and alterations of the immune system. Antibody-functionalized magnetic microbeads (MBs) are employed as the solid phase for the immunoassay, thus enabling easy and efficient microfluidic network cleaning and reconditioning between successive analytical runs. The use of chemiluminescence detection relying on hydrogenated amorphous silicon (a-Si:H) thin film photodiodes enables high assay detectability and wide dynamic range. Once validated in Space conditions, APHRODITE will be available for aiding in the investigation of the effects of the Space environment on the human organism. It will also be easily adapted to the detection of other biomarkers of interest, by supplying disposable cartridges with the necessary reagents.