

УДК 004.65

## INTELLIGENT EQUIPMENT CONTROL FOR SPACE APPLICATIONS IN ASTROGEOBIOLOGY: OXIDANT DETECTION ON PLANETARY SURFACES

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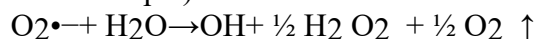
*Поступила в редакцию 18 октября 2019 г.*

**Abstract.** Measure superoxide and peroxide reactive oxygen species (ROS) on planetary surface (of Mars and Europa), terrestrial arid soils and icy surfaces. Construct an oxidant (superoxide and peroxide) detection instrument to study Mars topsoil oxidant chemistry, select non-oxidant sites on Mars/Europa for the identification of biomarkers of extraterrestrial life (extinct/extant), select least oxidant Mars sites for safe colonization by humans, study microorganisms' survival in ROS generating arid desert soils, and test cosmic/UV radiation-induced oxidative deterioration of the metal frame of manned spaceships from ROS. For the remote control of such instrument, intelligent equipment should be developed.

**Keywords:** Web OLAP; multidimensional data model; ER-model; situation-oriented database.

### INTRODUCTION

Past research for presence of oxidants on Mars: The release of O<sub>2</sub> gas from Martian soil recorded by the Gas Exchange (GE) experiment during the NASA Viking mission (consisting of two rovers sent at different months in 1976) was attributed by NASA in the possible existence of soil (metal) superoxide radical (O<sup>•-</sup>), because O<sub>2</sub> gas is a product (together with H<sub>2</sub>O<sub>2</sub>) of its dismutation reaction with H<sub>2</sub>O (from the nutrient medium that was mixed with the martian topsoil in attempting to grow microorganisms possibly existing in the tested soilsample):



The confirmation of this hypothesis is crucial because it would allow selection of sites on Mars, (a) less oxidatively destructive for the preservation of biomarkers (short of “molecular fossils”) for the discovery of extraterrestrial life, and (b) less toxic to future manned space missions. A first indirect indication for the existence of O<sup>•-</sup> on Mars was given in 2000 by the UV-radiation-induced generation of O<sub>2</sub> on the pure mineral labradorite (resenton Mars) under simulated Martian atmospheric condi-

tions, which was identified by EPR spectroscopy [1].

However, the Yen et al., 2000 team could not detect O<sub>2</sub> in better-simulated Mars soils (e.g. of the Atacama Desert in Chili) due to small sample size (0.1 g) and the low sensitivity of the EPR device to detect O<sub>2</sub> in the soil, as being present in various possible forms (adsorbed: O<sub>2</sub> ads; metal (Me) salt: Me O<sub>2</sub><sup>•-</sup>, Me (O<sub>2</sub>)<sub>2</sub>; complexed with Me: Me<sup>n+</sup> O<sub>2</sub>). However, this task has been accomplished by the Georgiou lab, which showed that besides O<sub>2</sub> H<sub>2</sub>O<sub>2</sub> and hydroxyl radicals (•OH) are generated (a) photochemically by Mars-like desert soils [2] and (b) by UV-exposed perchlorate (present on Mars topsoil at 0.4-1.5% w/w) containing Mars surface analogues [3]. These new developments make the existence of oxidants on Mars topsoil quite possible.

In November 1996, the Russian Federal Space Agency (RFSA or Roscosmos) launched the Mars '96 mission, which failed to escape the Earth orbit on its way to Mars due to the rocket failure. In this mission, NASA participated with the Mars Oxidant (MOx) instrument, which was designed to study Martian

topsoil oxidant activity [4]. The MOx instrument would have exposed oxidant non-specific sensor materials to the Martian soil, and monitored their reaction with the oxidants over time. Sensor materials included various metallic (eg. Al, Ag, Pb, Au) and organic layers (e.g., L- and D-cysteine). However, the MOx instrument would not have been able to identify these oxidants. Instrument construction for the detection of planetary It will be a direct approach based on wet chemistry whereby planetary soil

oxidants  $O^{\bullet-}$  and  $HO$  will be detected/quantified easily and precisely after being converted to  $O_2$  by enzyme (super-oxide dismutase, SOD, and catalase, CAT, their inorganic mimetics) – catalyzed chemical, catalyzed chemical reactions, which can then be measured by e.g. an  $O_2$ -electrode. The principle of the instrument has been verified by simulation experiments [5], and is diagrammatically shown in the following figure (fig. 1):

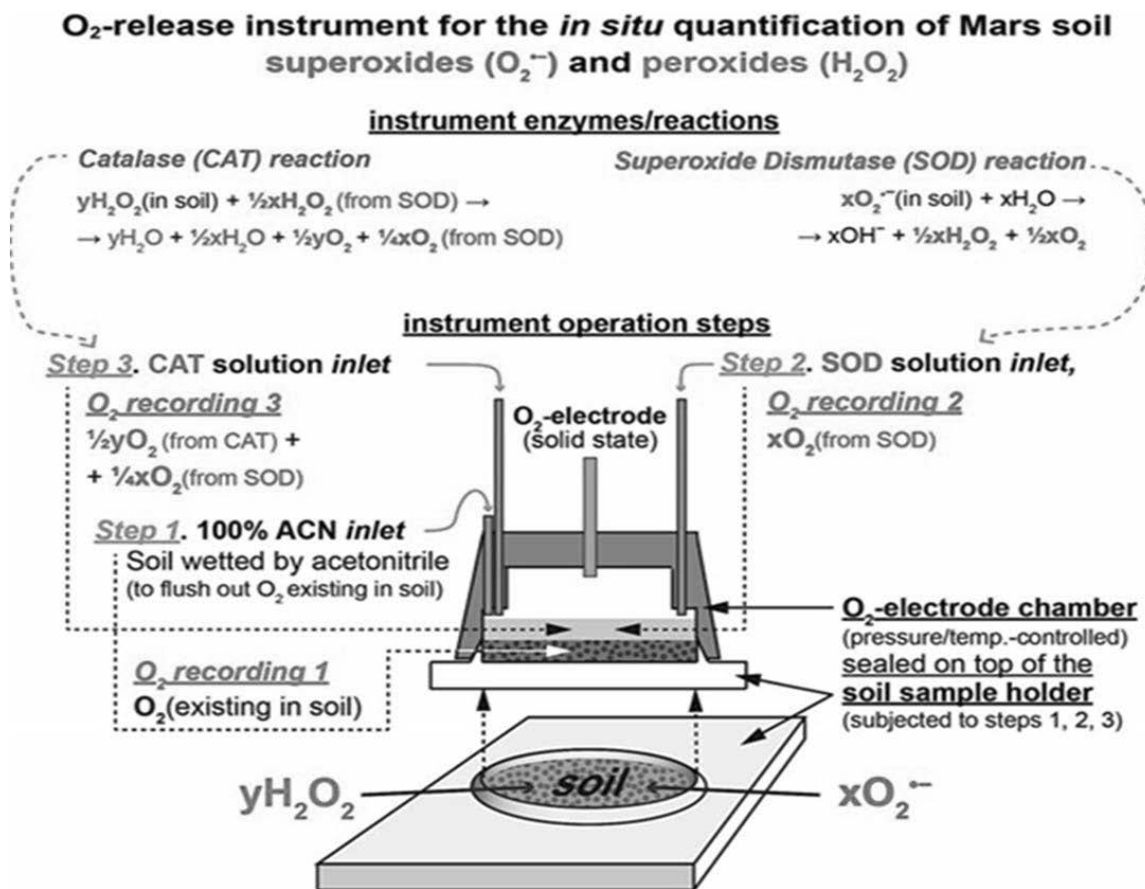


Fig. 1. Legend

Soil superoxide and peroxide concentrations are derived from released  $O_2$  values (recorded in Steps 1-3; colored released  $O_2$  denote source), which are defined as parameters of math functions (for  $y H_2 O_2$  and  $x O_2$  moles) based on the stoichiometry of the CAT and SOD reactions.

## CONCLUSIONS

This instrument must test samples from appropriate planetary topsoil sites. For example, testing Martian topsoil with such an instrument would require intelligent remote controlling at time periods where communication between Earth and Mars is interrupted. In addition, the 25-30 min delay

in sending/receiving commands and data between Earth and Mars should be accounted for.

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#### METADATA

**Title:** Intelligent equipment control for space applications in astrogeobiology: oxidant detection on planetary surfaces.

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**Language:** English

**Source:** SIIT (scientific journal of Ufa State Aviation Technical University), no. 2, pp. 30-32, 2019. ISSN 2686-7044 (Online), ISSN 2658-5014 (Print).

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