«Accumulator» Sub-Experiment of the «Resource» Experiment

# PROPERTIES OF HYDROGEN-CAPACIOUS COMPOUNDS AND CERAMIC MATERIALS ACTIVATED WITH HYDROGEN

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Properties of hydrides and the field of their application depend on hydrogen content in the materials. Metal hydrides of the periodical system group IV are objects of great interest because of their high specific density of the hydrogen atoms. The maximum H/Me ratio in these materials does not exceed 2:1, which corresponds to $MeH_2$ formula where $N_H \approx \approx 9.1 \cdot 10^{22}$ at·H/cm$^3$.

The fundamentals of new synthesis technologies for metal hydrides (with high hydrogen content), as well as ceramic materials based on carbon, boron and aluminium have been developed for the first time at the I. N. Frantsevich Institute for Materials Science Problems of the NASU. Titanium, zirconium and hafnium hydrides with hydrogen contents of $MeH_{2.3}$ to $MeH_{3.7}$ have been obtained. Titanium hydride produced by our technology has the composition of $TiH_{3.7}$ ($N_H \approx 16.1 \cdot 10^{22}$ at·H/cm$^3$). Hydrides of such composition have quantitatively new characteristics: their thermal stability with respect to decomposition and oxidation is increased up to 250—300°; their irradiation resistance is improved 1.5-2.0 times. Changes of lattice structure of the hydrides with higher hydrogen contents have been also observed. A unique property of these hydrides to interact chemically with light inert gases, namely helium and argon, has been established.

In view of the good prospects for utilisation of aluminium and boron nitrides (as well as of compositions based on them) in space systems such as antenna windows and rocket fairing, it is interesting to study the influence of space factors on the physical-mechanical properties and structure of ceramics with improved characteristics, in order to determine their possible service life under these conditions.

The need to carry out experiments in open space (under the influence of cosmic radiation, long-term microgravity and very low pressure) is also due to the possibility of practical application of hydrogen-capacious materials and ceramics activated by hydrogen in space as:

1) powerful hydrogen source as ecologically pure fuel;
2) components of solid rocket fuel;
3) materials for protection from cosmic radiation;
4) biological protective materials for nuclear reactors;
5) regulators of fast neutron flows (zirconium hydride) in nuclear reactors;
6) antenna windows and rocket fairing (ceramics).

Intermetallic hydrogen accumulators can be used in this experiment in two aspects: 1 — as working materials — hydrogen sources, for ensuring the functioning of devices and life-support systems of a manned space station; 2 — as objects of study under the space conditions as promising materials of working elements of spacecraft in the future.

The principal task of this experiment is to study the influence of open space conditions (low pressure, cosmic radiation, and microgravity) on the following properties of the materials:

- for hydrides with increased hydrogen content:

1) hydrogen content as the main characteristic of hydrogen-capacious materials;
2) thermal stability of hydrogen-saturated materials;
3) structural lattice changes of hydrogen-capacious compounds;
4) changes of the electronic structure and chemical bonding of materials with an anomalously high content of hydrogen.

- for ceramics with improved properties:

1) chemical and phase composition of materials;
2) electrical insulation properties;
3) mechanical characteristics;
4) thermal stability;
5) chemical stability.

The following hydrogen-containing materials are planned to be used: a) 100×100×10 mm briquettes of up to 5 kg total weight, b) 40×40×10 mm ceramic briquettes of up to 2 kg total weight. The mentioned briquettes will be fixed in stainless steel frames. Containers with test materials should be located on the platform outside the ISS and should be exposed to all changes of space conditions during the whole operational period of the ISS.

Study of the influence of very low pressures, cosmic radiation and microgravity on the properties of hydride-forming materials undoubtedly is of prime importance for development of space materials science.

«Poplar» Sub-Experiment of the «Resource» Experiment

## SOLAR THERMAL ELECTRIC POWER COMPLEX FOR ORBITAL SPACE STATION

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The development and study of the Solar Thermal-electric Power Complex (STPC) is aimed at creation of a power source with higher efficiency, reliability and long-term life.

Realisation of the experiment is based on previous research carried out at the Institute for Materials Science of NASU and on the following main results obtained:

— Optimisation of high-temperature thermoelectric materials and thermoelectric element cascading permit increasing the temperature gradient, as well as decreasing the power degradation down to 5 % (after 10000 hours of operation);

— Use of a solar concentrator for heating of hot junctions of thermoelectric elements and of heat tubes for heat removal from the cold junctions permit intensifying the heat exchange and increasing the specific power up to 2 W/cm$^2$, and the efficiency up to 15 %.

The main purposes of the space experiment are the following:

— testing the performance of the power complex and its units and components when exposed to space radiation, vibration, and over-loading during putting into orbit and operation in space;

— studying the influence of weightlessness on the heat carrier transfer in heat tubes;

— determination of the functional effectiveness, reliability and fatigue of the STPC in space.

The experimental space system consists of STPC; two blocks BC-1, BC-2 for control, storing and processing of the data; platform for STPC and BC-1 assembled on the outer side of the OSS; cables; container for storage and transportation of STPC, BC-1 and BC-2. The STPC consists of three main units, namely solar concentrator, thermal battery and heat tubes.

The following main operations are provided:

— measurement of the irradiency in the focal spot of the solar concentrator;

— switching of two modes, namely no-load and short circuit (obtaining the volt-ampere characteristics (VAC));

— computer storage of the VAC data and pyrometer readings;

— processing the VAC data.

The work has been carried out within the framework of the International program of the USA, Russia, and Ukraine (NASA, RAS, NASU) for the ISS.