PRODUCTION OF NEW UNIQUE MATERIALS IN SPACE («Material» Project)

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Introduction. Experiments of the «Material» project have a common purpose to make materials with new useful properties under microgravity conditions, which cannot be produced under the effect of terrestrial gravity. The processes of heating, melting, spraying, cooling, and crystallisation are used in all experiments for producing the samples. It involves a study of the dynamics of energy-mass transfer, structuring, and other micro- and macro-processes. However, tasks, methods, objects of study, and applied equipment differ essentially in these experiments. So, typical servicing equipment will be used to carry out the «Coating» and «Diffusion — Mono» experiments, whereas development of the new on-board equipment will be necessary for «Priority», «Levitechn», and «MGD-COSM» experiments.

Experiments can be classified in the following groups by the method of heating:

— *Radiation heating* ⟶ «Diffusion — Mono», «Priority», «Levitechn» experiments;

— *Laser heating* ⟶ «Levitechn» experiment;

— *Electron beam heating* ⟶ «Coating» experiment;

— *Induction high-frequency heating* ⟶ «Levitechn», «MGD-COSM» experiments;

— *Concentrated solar energy heating* ⟶ «Levitechn» experiment.

The diversity of these methods is due to the requirements of the technological processes to such parameters as temperature, heating rate, vacuum, gas-filling, spatial access, power-intensive operations, etc.

Various means and methods are proposed to keep samples in the molten and solid states in the experiments:

— *In containers* ⟶ «Diffusion-Mono», «MGD-COSM» experiment;

— *In glass ampoules, and also by surface tension forces and by the ends of an unmelted rod in floating-zone melting* ⟶ «Priority» experiment;

— *In levitators without containers* ⟶ «Levitechn», «Coating» experiment.

The latter method of keeping samples in levitators without containers is still little known. In the recent years the «ELF», «Tempus» and other levitator projects have been proposed in the West, and the «Levitechn» levitator has been considered in Ukraine. This method should be applied for the super pure and high-temperature technologies, which require contactless control of melt position, shape, and motion (i. e. for brazing and welding under microgravity). The measuring and registering systems for all the experiments are rather similar and can be unified, for example, as it is suggested in the «Technology» experiment.

The «Priority» experiment is of great commercial interest for Ukraine. For example, the weight of a matrix infrared receiver is 0.1 grams, and its cost is about several thousand US dollars. The volume of world sales of various infrared devices on the basis of hierarchical photodetectors with the narrow-band-gap $Cd_xHg_{1-x}Te$ semiconductor materials is more than $ 10 billion. Under the space conditions, it is possible to produce up to several hundred grams of this material with low power consumption, as well as reach a state of integration of the units of a matrix by 1 — 2 orders higher than that on the ground. Taking into account the small weight of these products, there is a high interest to organize their profitable manufacture in space.