under the usual conditions. Such zero gravity experiments on model systems with the low melting point of the matrix will allow us to develop methods of obtaining especially fine dispersions, and they will also help to clarify the mechanism of crystallization of disperse systems with application of ultrasound.

The knowledge obtained during the project will provide a physical background for development of the technology of producing new composite materials for aerospace and electronic engineering.

The developed ultrasonic equipment will be also used in the experiments of an independent biological project of the Institute of Biochemistry of the NAS of Ukraine. This project is devoted to the study of functional abilities of diaphragms under the conditions of microgravity to obtain suspensions of one-molar liposomes, which is achieved by destruction of large multilayer vesicules with ultrasound.

The Institute of Metal Physics is planning to make a flight unit for obtaining the composite materials using an ultrasonic field under microgravity onboard the Ukrainian Research Module of the ISS. The unit is designed for performance of the above-mentioned and other research.

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ELECTRON BEAM ZONE MELTING OF Ni-BASE EUTECTIC

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One of the promising methods of obtaining the modern composite materials is the unidirectional solidification (DS) of the eutectic alloys by means of electron beam zone melting. The characteristic property of this method is gradual solidification of the sample by moving the melt zone. Under these conditions, a perfect structure designed and oriented in the specific crystallographic direction is formed in the sample. Existence of such a structure leads to the unique physical-mechanical properties of a sample. The advantages of this method of obtaining the composite materials are the one-stage processes controlling the morphology of the phases and perfection of the material structure. The number of investigations concerning the influence of microgravity, in particular, on the process of solidification, has considerably increased, as they offer outstanding possibilities of the material structure control.

Among the composite materials currently obtained by electron beam zone melting, the most promising are Ni-base eutectic alloys reinforced by refractory metal carbides, in particular, the alloys of Ni-Nb-C system. It was this system which formed the base for development of the currently used alloys for the turbine blades. Alloys proposed for this experiment are being currently manufactured. They have a relatively low melting temperature (full power for maintaining the liquid zone during electron beam zone melting is 200 W). The authors have carried out calculations and ground-based experiments with alloys of this simple system. The basic mechanism of formation of a perfect oriented composite structure has been worked out [1, 2]. At present the eutectic composites are being improved by making them more complex. To this end, variation in the number and concentration of the alloying elements is accompanied by changing the temperature-concentration parameters of the eutectic transformation and by decreasing the DS velocity. In order to design advanced superalloys, it is necessary to know how the DS parameters (DS velocity, temperature gradient on the crystallisation front) and characteristic properties of each alloying element affect the structure of the composites. The decrease in the gravity level should change the macro- and microstructure of composites.

Production of DS eutectic alloys by zone melting has some difficulties under the ground conditions. On the one hand, a liquid zone is overheated by the electron beam that is necessary to obtain high temperature gradients, and at the same time it is limited by the flowing quality of the melt. On the other hand, the overheating of a melt generates the thermoconvection process, which upsets the planar front stability and causes an increase of the number of structural defects. DS under microgravity will enable stabilisation of the influence of these factors for creation of a perfect eutectic structure.

The experiment will be carried out in two stages. At the first stage, a series of technological DS experiments with the Ni-Nb-C alloys will be performed under microgravity. They are intended to study the composite growth field of alloys in the direction of the increase of the strengthening phase content. At this stage, a great number of sub-experiments will be conducted with various solidification velocities to establish the maximum velocity during the existence of the planar front. At the second stage, DS experiments with complex alloying (6—10 alloying elements) will be carried out. These experiments are intended to determine such a segregation level of various elements where the composite structure formation is slowed down. It is also proposed to assess the influence of overheating of a melt zone and convection on the planar front stability.

The obtained data will allow us to work out recommendations for the eutectic and non-eutectic DS on the ground.

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«Brazing» Experiment

CAPILLARY PROPERTIES OF METAL MELTS, NON-METAL MATERIALS AND PROCESSES OF WETTING AND BRAZING UNDER MICROGRAVITY

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The experiment pursues two main objectives.

The first one is to test one of the fundamental laws of physical chemistry on the surface phenomena, namely the second capillarity law about the independence of wetting contact angle on gravity [1, 2]. It is intended to carry out measurements of wetting contact angles under normal conditions and microgravity in low-temperature systems, where both wetting ($\Theta < 90°$) (water, glycerine — polyvinylchloride, nylon) and non-wetting ($\Theta > 90°$) (water, glycerine — paraffin, teflon) are observed. The solution of this problem will provide an answer to the fundamental question of whether Young's equation (1), which has been used for almost two centuries now, holds true or whether wetting contact angles and all the related processes depend on gravitation:

$$\cos\Theta = (\sigma_{sg} - \sigma_{sl})/\sigma_{lg} \qquad (1)$$

(Θ is the contact angle; σ_{sg}, σ_{sl} and σ_{lg} are the surface tensions at solid-gas, solid-liquid and liquid-gas interfaces, respectively).

This answer will allow not only a correct interpretation of the obtained results, in particular concerning liquid phase sintering, but also developing experiments and technological processes with use of