magnetized workpieces (see Fig. 1). This influence led to smaller grain size and decreased overheat zone dimensions. Furthermore, the microhardness distribution over width and height of the weld joint is more uniform in this case.

Conclusion. The results of the experimental studies support the use of alternating current in a rectangular arc welding with coated electrodes magnetized details, because it provided high quality and strength characteristics of permanent connections, and significantly simplifies the process of repair of details with residual magnetism.

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Material Processing in Space

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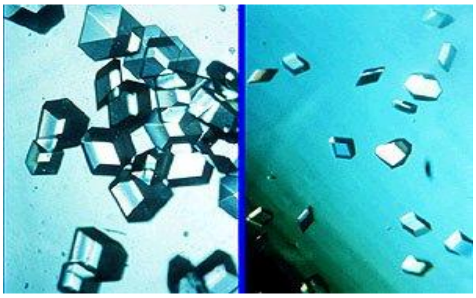
Materials processing is the science, which researches how ordinary and comparatively inexpensive raw materials can be made into useful crystals, chemicals, metals, ceramics, and other manufactured products with the necessary properties. Materials processing makes it possible to produce chemical and biological compounds for use in medicine, different types of plastics, alloys, ceramics for use in a variety of the goals [1].

Materials processing on Earth allow us to rise our spacecrafts into the Earth orbit. There the extended benefits of working in especial conditions have opened new and unique opportunities for the science of materials processing. In the microgravity environment of an orbiting spacecraft, scientists can make procedures that are impossible on surface of the Earth.



Picture 1 - Comparison of insulin crystal growth inouter space (left) and on Earth (right)

Materials processing in space (MPS) has been studied both theoretically and experimentally for over ¼ of a century. The experiments with the material processing in space were first realize relatively recently. In the USSR, the first technological experiments were carried out in 1969 on board the manned spacecraft "Soyuz-6". Cosmonaut Kubasov V. N. was working out different ways of welding metals using equipment called

"Volcano" in condition of long weightlessness. Technological experiments were also made in 1975 during the flight of the orbital station "Salyut-4", and also duging joint flight "Soyuz" and "Apollo".

Researches on space technology were also being conducted in the USA and other countries. Different technological experiments were carried out on the board of spacecrafts "Apollo-14, -16, -17," on the orbital station "Skylab" [2].

In the beginning, there were not enough information about “zero gravity,” absence of convection, growth of perfect crystals, and eventual manufacturing in space. There was a lot of surprises, and not all experimental results have yet been satisfactorily explained. Gravity was found to influence processes that were thought to be gravity-independent [3]. But the space environment was not magic and the materials were not sufficiently better to warrant the costs. The value added did not exceed the additional cost. One consequence is that materials processing on Earth has been improved in the many fields. And it is difficult to imagine how the materials-processing industries could have developed without knowledge, which were received during the work materials processing in space. This knowledge has proven to be extremely useful in improvement and innovation of materials processing on Earth.

Beginning with the first technological experiments on metal welding performed in 1969 on the Soviet spacecraft "Soyuz-6" with equipment "Volcano", works into two directions:

1) development of methods of installation, assembly and repair of products in space

2) production of metals and alloys with improved properties.

Conditions in space are strong different from the conditions on Earth. The most important differences, which allow us to get a unique properties of materials:

- Zero gravity (microgravity);
- Deep vacuum;
- Extremely high and low temperatures [4].

Microgravity

In orbit, materials processing can be accomplished without the effects of gravity, which on Earth causes materials of different densities and temperatures to separate and deform under the influence of their own masses.

Zero gravity means no convection currents in molten material, which allows purer material separation processes, mixing of materials which would separate due to gravity on Earth, and perfect crystallization processes (e.g., for solar cells and microelectronics). Many alloys and crystals are easily producible in space, which are practically impossible to make on Earth.

Vacuum

The pure vacuum environment in space offers many advantages in manufacturing. Vacuum prevents air contaminants. More importantly, however, it allows industrial processes which are difficult or completely infeasible on Earth due to interference by air and the expense and difficulty of producing vacuum in an industrial facility at the bottom of Earth's ocean of air.

The space vacuum is much purer than what is feasibly producible on Earth at great cost, and it's abundant and free in space [5].

Temperature

Sun is one of the most powerful source of energy in space, which can be reached by people. It allows people use its energy for heating researched materials to extremely high temperature. Also due to deep vacuum, which doesn`t have thermal conductivity, we can cool to very low temperature, what is more it can be done very fast, during very short period of time.

Some examples of potential applications derived from MPS research are as follows.

Crystal Growth

Melt growth is the most widely exploited technique to produce high-technology, single-crystal materials for semiconductor chips used in large-scale integrated circuits for communications and computers. Chemical homogeneity, which will maximize electrical performance, is believed possible through microgravity processing. Commercially valuable crystals for sensitive infrared sensors, most difficult to grow on Earth, may be enhanced by melt growth in a microgravity environment.

Containerless Processing

Containerless processing eliminates problems of container contamination and wall effects, often the greatest source of impurities and imperfections while forming molten material. In microgravity, a material may be melted, manipulated, and shaped, free of contact with a container by using acoustic, electromagnetic, or electrostatic fields. Surface tension would hold the material together in mass, a force overpowered here on Earth by gravity.

Solidification

Control of the solidification of metals and alloys is the key element in the field of metallurgy. Gravitational effects, such as buoyancy-driven convection of the melt or sedimentation, can greatly influence the structure of metals and alloys. Directional solidification in microgravity allows complicated shapes, such as turbine blades, to be melted and directionally solidified to increase axial strength while using a thin oxide skin to maintain the shape. Additional interest is based on the potential of approaching the theoretical maximum magnetic strength of materials that are 10 times higher than currently realized on Earth. Solidification kinetics in the casting of alloys under nonterrestrial conditions can produce fine-grained structure in the interior of a casting. This phenomenon could have application in common products such as iron engine castings [5].

Over the next years, space-based research will stress both scientific and commercial goals. Products will include crystals, metals, ceramics, glasses, and biological materials. Processes will include containerless processing and fluid and chemical transport. As research in these areas develops, the benefits will become increasingly apparent on Earth: new materials, more efficient use of fuel resources, new pharmaceuticals, advanced computers and lasers, and better communications. Like space, the opportunities offered by microgravity science and applications are vast and are only beginning to be explored [1].

Space processing techniques which yield products of high value and low volume may be commercially feasible. It must be recognized that even if a material is identified that is sufficiently unique, useful, and valuable to be manufactured or processed in space, the high inherent cost of space processing will be a strong incentive for industry to find means of duplicating the process on the ground or to find a cheaper substitute for the material. For this reason it may be desirable for the Government to subsidize the initial phases of MPS research and product development.

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