objects created in the Institute of biomedical problems of RAS and the Cologne Institute for space medicine. The Russian side also is a contractor in the conduct of contractual experiments ESA and the Japanese aerospace exploration Agency. For example, Russian cosmonauts have conducted tests of experimental robotic system ROKVISS, developed at the Institute of robotics and mechatronics, located in Webling, near Munich, Germany.

The main problem which the ISS has it is its maintenance [5]. Always something needs to be fixed at the station, or other technical works must be carried out.

Despite all the complexity of the design of the ISS, most of the tools on it are made so that layperson could hold some technical work. Of course, each astronaut is a professional, but he is not to do everything and his skills may not be enough to perform a particular maintenance activity. But especially complicated repairs performed outside the International comic station, as it requires going into open space. Such each withdrawal is planned for a long time and worth a certain amount of money. That is why at the present time considers the options of sending into space special robots, which will be managed remotely and will be able to replace the man in time outside activities.

At the moment attend great attention to the development of the international space station. Planned are further improvements laboratories and delivery of new equipment for the experiments, the number of which will increase which will lead to the rapid development of science and space exploration.

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Titanium in Spacecraft

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Aerospace and space industry has traditionally been a pacemaker for development and introduction of new materials systems and production technologies. Probably no other metal is more closely associated with aerospace than titanium.

Titanium is a rather new metal and is, probably the last addition to the comparatively small group of structural materials for different constructions. Along with iron, aluminum, magnesium, copper, and nickel, it becomes one of the essential metal materials for modern spacecraft, as its reserves in the Earth’s crust are rather big [1].

The strength of the titanium alloys varies over a wide range. This is because the properties are dependent on the alloy composition and heat treatment. However, the specific strength properties of titanium alloys are superior to the other materials (expect carbon- epoxy composite), and for this reason they are good materials to use in aircraft structures required to carry high loads, such as airframe components, undercarriage parts, and wing boxes.

Other benefits of using titanium include high strength, good fatigue resistance, creep resistance at high temperature, and excellent oxidation resistance up to 600 C. Certain types of titanium alloys can be joined by welding or diffusion bonding; thereby reducing the need for mechanical fasteners (bolts, screws, rivets) and adhesive bonding that is a requirement for age-hardened aluminium assemblies. Titanium has better resistance to corrosion than high-strength aluminium alloys, including the most damaging forms such as stress corrosion cracking and exfoliation. Titanium has the ability to form a thin oxide surface layer, which is resistant and impervious to most corrosive agents and which provides the material with excellent corrosion resistance. Titanium is used as a replacement material for aliminium in aerospace structures when corrosion resistance is the prime consideration.

Disadvantages of using titanium include relatively high density compared with aluminium alloys and carbon-epoxy composites. However, it is lighter than nickel superalloys when used in jet engines. A major disadvantage of titanium is the high cost, which varies with the usual price fluctuations in the global metals commodity market; the raw material cost is typically $10000-12000 per tonne. The high cost is the result of the expensive process used to extract titanium from its ore together with the costly processes used in fabricating and shaping the metal into an aerospace component. Titanium is difficult to machine and requires specialist material removal processes (such as-laser-assisted machining) to produce aircraft components free of machining damage [3].

Titanium is a metal of great interest in the aerospace industry, because of its combination of good mechanical properties, low density, and operability in a number of special forming processes. Titanium is recognized for its high strength-to-weight ratio. It is a light, however, strong metal with low density. Titanium can be alloyed with other elements such as iron, aluminum, vanadium, molybdenum, etc., to produce strong lightweight alloys for aerospace. The two most useful properties of the metal are corrosion resistance and the highest strength-to-weight ratio of any metal. Further its ability to withstand fairly high temperatures has focused attention on its increased use in the aerospace and allied fields; however, full utilization of titanium in the aerospace industries is prevented by its tendency to gall and seize and its severe reactivity to atmospheric oxygen at elevated temperatures. In order to overcome these limitations and meet some functional requirements, suitable surface treatment of titanium is of utmost importance.

Titanium alloys are difficult to plate with adherent metal coatings because they form a tenacious, passive oxide film quickly. The oxide film may be removed by various etching procedures, but the oxide film reforms so rapidly that it is difficult to accomplish any coating before the film reforms to block access of the plated atoms to the surface. If the plating is accomplished over the oxide film, a layer of metal can be deposited, but the layer is not sufficiently adherent for most purposes.

There is therefore a continuing need for a method of coating metals such as electroless nickel onto titanium, particularly on its alloys. The present investigation reports a study of blackening of titanium alloys with higher optical properties for spacecraft applications [2].

Due to the comparatively small payload of space vehicles, saving weight in these structures is even more important than in aircraft. For this reason, titanium alloys were used extensively in the first Apollo and Mercury programs. Fuel and satellite tanks are regarded as a standard application for titanium alloys. Titanium’s low weight, high strength, and long term chemical compatibility with fuel give titanium alloys an advantage over high-strength steels. Furthermore, the integrity of the tanks must be reliably non-destructively tested before being sent into orbit, which is most consistently done for metallic tanks. Non-metallic components require additional efforts to ensure their integrity. Figure 1 shows pressure vessels made from titanium alloys for the US Space Shuttle program.

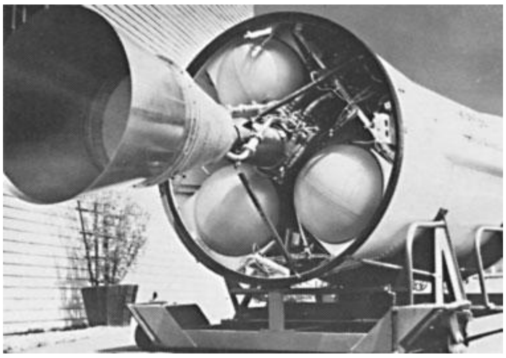

Figure 1 - Pressure tanks manufactured from titanium for space transportation system

The requirement for extremely lightweight satellite component construction dictates very intensive, weight-optimizing manufacturing techniques. Under favorable conditions, the final fuel tank wall thickness in commonly used satellite propulsion systems is machined from 25mm thick forged half-shells to less than 1 mm. Figure 2 shows a tank used for the Attitude Control System on the Ariane 5 [4].

Figure 2 - Attitude Control System tank of titanium half shells

The rocket industry is, as the aircraft and spacecraft industries, a considerable titanium consumer.

Titanium alloys were widely used in the Russian piloted spacecraft Vostok and Soyuz, in the unpiloted Luna, Mars, and Venera, and in later space systems Energiya and the orbiter Buran. The use of titanium in these spacecraft is efficient with respect to the weight gain, especially in multistage rockets. The major applications of titanium are solid-fuel and liquid-propellant rocket engines, skin, black-powder engine casings, tubular constructions of stage sections, various aggregates, in particular, high-pressure gas vessels, fasteners, etc [1].

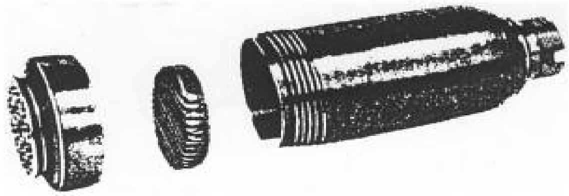

Figure 3 - Correction solid engine from titanium alloy VT22

The industry has been cyclical in nature and has operated at peak capacity only a few times in the approximately five decades since titanium was introduced as a commercial material. The business conditions of the last decade of the twentieth century led inexorably to a consolidation of the producers of titanium alloys. Further consolidations may be expected in the alloy specifications that govern the use of titanium. Common specification agreements are in the works whereby a single specification may serve as a buying for a given composition. Single specification requirements for a given alloy should not be considered to grant a common design data base for a material, however. Actual design data will continue to be within the purview of titanium users such as gas turbine engine and airframe manufactures. Commonality of purchasing requirements via common specifications should eventually drive design data to a more common framework.

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Active Orientation Systems, Stabilization of Artificial Satellites

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INTRODUCTION

Artificial bodies, such as satellites, are used to study the Earth, other planets, to help us communicate, and even to observe the distant Universe. The first artificial satellite was the Soviet Sputnik 1 mission, launched in 1957.Satellites are launched into different orbits depending on their mission. One of the most common ones is geosynchronous orbit. This is where a satellite takes 24 hours to orbit the Earth; the same amount of time it takes the Earth to rotate once on its axis. This keeps the satellite in the same spot over the Earth, allowing for communication sand television broadcasts. Another orbit is low-Earth orbit, where a satellite might only be a few hundred kilometers above the planet. This puts the satellite outside the Earths atmosphere, but still close enough that it can image the planets surface from space or facilitate communications. Artificial satellites can have a range of missions, including scientific research, weather observation, military support, navigation, Earth imaging, and communications. Some satellites fulfill a single purpose, while others are designed to perform several functions at the same time [2].

ATTITUDE AND ORBIT CONTROL

In order to control an autonomous vehicle, it is fundamentally important to know its attitude. For manned aircraft, roll, pitch and yaw can be obtained through orientation by an inertial reference, usually the ground, or instruments such as an artificial horizon or a compass. Still all of them are dependent on pilot interaction. For unmanned platforms, it becomes necessary to use an electronic device capable of measuring physical quantities related to that goal. A device that aggregates these sensors is called IMU (Inertial Measurement Unit). An IMU contains inertial sensors that measure linear acceleration and angular rate, among other physical data. Through reading and fusing these data it is possible to obtain attitude information which, applied to flight history, can help to