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HEAT-RESISTANT MOSI2 – NBSI2 AND CR-NI COATINGS FOR ROCKET ENGINE COMBUSTION CHAMBERS AND RESPECTIVE VACUUM-ARC DEPOSITION TECHNOLOGY

Abstract

Liquid-propellant thrusters use niobium-based alloy combustion chambers. These alloys are characterized by high heat resistance, but require protection from high-temperature oxidation. Coatings are most effective in protecting the combustion chamber wall surface from high-temperature oxidation. The most effective are ceramic coatings, for example, silicide. Silicide coatings are obtained in two stages. At the first stage, a 40-50-micron thick layer of molybdenum is applied to the surface of the combustion chamber walls. At the second stage, the molybdenum layer and the near-surface layer of the combustion chamber wall are diffusion-saturated with silicon. This results in a complex 100-120-micron thick MoSi2 – NbSi2 silicide coating. Such coatings can protect the surface of the combustion chambers walls from high-temperature oxidation at up to 1800C. The thickness of the MoSi2 based heat-resistant coating on the combustion chamber surface made of niobium alloys can vary. The coating consists of a MoSi2 layer with a sublayer of niobium silicides, the total thickness of which is the thickness of the heat-resistant coating. The high efficiency of the coatings is provided by applying a molybdenum layer by ion-plasma deposition, which ensures high adhesion and continuity of the coating. The ratio of the thicknesses of the MoSi2 and niobium silicide layers, which make up the thickness of the heat-resistant coating, as well as its heat resistance is controlled by the ion-plasma deposition process parameters. The heat-resistant coatings have been obtained by vacuum-arc deposition of molybdenum on complex-shape surfaces. For cooled combustion chambers, the coating can be made of multicomponent metal Cr-Ni alloy based heat-resistant materials. At a lower operating temperature, such coating has high strength, relative ductility, and low brittleness. The coating does not crack during processing and operation. The multicomponent nature makes it possible to form several structural phases of the coating, and vacuum deposition with a small amount of nitrogen enables the formation of nitride compounds in the form of both distributed dispersed inclusions and continuous surface layers. Nichrome 78 can serve as an example of such a coating material. Coatings up to 200 m in thickness with different structures have been obtained: solid dense, fine- and coarse-grained, with different contents of the drop phase after deposition, a combination of a nitrided coating with a dispersed non-nitrided drop phase.