COMPUTER SIMULATION OF THERMAL FIELDS OF THE B-TI AND LAB6-TI SYSTEMS FOR BORIDE SURFACE ALLOYS FORMATION USING A LOW-ENERGY HIGH-CURRENT ELECTRON BEAM *

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Titanium and titanium alloys have found wide applications in various industries due to good corrosion resistance, good biocompatibility, high specific strength and fatigue resistance. However, there are disadvantages to titanium and its alloys. In particular, they have poor tribological properties, which can be a limiting factor in the service life of titanium products. Various surface treatment methods are considered to improve the tribological properties of products made from titanium materials. One promising way to achieve the desired properties is boriding. Boriding forms surface layers with improved wear and corrosion resistance by increasing the surface hardness of the substrate. Boride layers protect titanium from the environment by forming a stable passive film, high wear resistance and ultra-high adhesion to the titanium surface. One of the methods of forming boride layers is the synthesis of boride surface alloys using a low-energy high-current electron beam (LEHCEB) [1].

In this work the temperature fields for the two-component systems B (film)-Ti (substrate) and LaB_6 (film)-Ti (substrate) were calculated. Melting thresholds for pure metals were calculated: Ti -2.0 J/cm^2, B - 2.9 J/cm^2, LaB_6 - 5.0 J/cm^2. The dependence of B and Ti melting thresholds for the B-Ti system as a function of B layer thickness was calculated. The dependence of LaB_6 and Ti melting thresholds for the LaB_6 -Ti system as a function of LaB_6 layer thickness was calculated. It was found that for all this systems, the Ti substrate material is the first to melt upon exposure to the LEHCEB. The film material then begins to melt. The values of LEHCEB energy densities at which the refractory material of B and LaB_6 films is completely melted have been calculated. These values of LEHCEB energy densities are proposed to be taken as the melting thresholds of the B-Ti and LaB_6-Ti systems. For the B-Ti system, the melting threshold of the system increases monotonically with increasing film thickness B from 3.0 J/cm^2 at 0.1 μm film thickness to 8.5 J/cm^2 at 2.0 μm film thickness. For the LaB_6-Ti system, the melting threshold of the system increases monotonically with increasing LaB6 film thickness from 4.4 J/cm^2 at 0.1 μm film thickness to 8.2 J/cm^2 at 2.0 μm film thickness. On the basis of the results obtained, the optimum values of the film thicknesses of the investigated systems were selected. The dependencies of the melt thickness on the LEHCEB energy density have been calculated for the systems B(0.5)/Ti and LaB_6(0.5)/Ti. The dependencies of the lifetimes of the film and substrate melts on the LEHCEB energy density have been calculated for the systems B(0.5)/Ti and LaB_6(0.5)/Ti. Temperature profiles at the film surface and at the film/substrate interface as a function of NSEP energy density have been calculated for B(0.5)/Ti and LaB_6(0.5)/Ti systems. The optimum conditions for the synthesis of surface B-Ti and LaB_6-Ti alloys have been determined numerically.

REFERENCES

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