ACOUSTIC SIGNALS IN NI-AL COATED STEEL INDUCED BY IRRADIATION WITH A LOW-ENERGY HIGH-CURRENT ELECTRON BEAM

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The increasing requirements of modern technologies for the formation of new materials and coatings the constant development of scientific methods, techniques of monitoring the characteristics and properties of materials during their modification is required. Exposure by the intense pulsed electron beams is a universal way of modifying the material and forming of various compositions surface alloys. In material or a coating during pulsed exposure by electron beam the thermoelastic stresses is occur. These thermoelastic stresses are sources of acoustic waves. Acoustic waves propagating from the interaction region carry information both on the energy properties and spatial distribution of the particle flux and on the thermodynamic processes during the formation of surface alloys. This acoustic effect can become the basis of a new method for studying the properties of new materials and processes during their formation.

Of particular interest are nickel-aluminide intermetallic compounds such as NiAl and Ni_3Al. The perspective of their use is the necessity to create a new type of high-temperature and high-strength structural materials. The choice of nickel-aluminide intermetallic compounds is justified by high melting points, relatively low densities, good strength and resistance to oxidation. These intermetallic materials have great potential for use in automobile engines, aircraft, as well as in equipment for the production and conversion of energy.

In this work, to form a surface intermetallic compound Ni-Al, an electron-beam machine RITM-SP is used [1]. It operates on the basis of a source of a low-energy high-current electron beam (LEHCEB) created at the Institute of High Current Electronics SB RAS. A distinctive feature of this machine is a wide-aperture electron beam. It provides uniform physical properties over the entire coating area and the absence of problems with coating adhesion. The coatings (surface alloys) formed by this method can be a thickness from fractions to tens of microns.

The action of a pulsed electron beam on a solid creates acoustic waves in it. The amplitude of these waves is proportional to the radiation power density. It is proposed to use radiation-acoustic diagnostics to measure the energy of a pulsed electron beam [2]. Radiation-acoustic diagnostics is based on the registration of acoustic waves in the target during the dissipation of the energy of a pulsed electron beam. This is the so-called radiation-acoustic effect. The object of research is acoustic processes during the formation of surface alloys by LEHCEB.

The study of acoustic signals induced by the action of a LEHCEB of microsecond duration on a Ni-Al coating is presented. The Ni-Al alloy was formed on a steel substrate by sputtering and subsequent single irradiation of the multilayer system Ni(0.5 μm) – Al(1.5 μm) – Ni(0.5 μm). The typical forms of acoustic signals generated during exposure to a multilayer Ni(0.5) / Al(1.5) / Ni(0.5) / Fe multilayer system were experimentally obtained. It has been established that, during the action of an LEHCEB, acoustic signals have groups of characteristic spectral components whose frequencies depend on the type of sample. It has been established that during the influence of the LEHCEB acoustic signals have groups of characteristic spectral components. It was shown that the amplitudes of the characteristic spectral components for Ni-Al coatings depend on the charge voltage of the electron beam.

REFERENCES

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