INVESTIGATION OF THE KINETICS OF THE SHS PROCESS, INITIATED USING ELECTRON-BEAM TECHNOLOGY*

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This paper presents experiments on the hardening of the aluminum alloy surface by intermetallic phases of the NiAl system. The aluminum plate was coated with a thickness of about 0.2 μm of heat-resistant nickel alloy $NiCr_{20}TiAl$. After, the plate with a metal coating applied to it was exposed to a series of pulses of a wide-aperture low-energy high-current electron beam with duration of about 5 μs in the installation "RITM-SP". As a result, the SHS process is started between the metal film and the aluminum base, which lasts several tens of milliseconds.

However, the control of the surface electron-beam alloying process of significantly complicates the instability of the electron beam pulse parameters and the process of its interaction with the processed material, which leads to some random changes in quality indicators that occur spontaneously, regardless of the control system. In this situation it is convenient to use vibroacoustic analysis to track the process.

To register the vibroacoustic signal generated during the technological process, the substrate was connected to the accelerometer using a waveguide in the form of a copper wire with a cross section of 2.5 mm^2. The use of a wire waveguide made it possible to have the recording equipment at a distance from sources of electromagnetic interference.

Experiments have shown that the components in the frequency range up to 40 kHz stand out against the background of noise. Low-frequency components up to 1 kHz were excluded from consideration. The recorded vibroacoustic signal was subjected to time and frequency analysis. Effective (mean square) values of the amplitude of these signals filtered in different frequency ranges were taken as parameters of the vibroacoustic signal reflecting the kinetics of the process.

It is observed that the amplitude of the vibroacoustic signal for the case of a coated sample increases significantly, starting from the third-fourth pulse. Analysis of optical images confirmed that the formation of intermetallic phases on the surface of the aluminum plate under irradiation by the first pulse, as a rule, does not occur. The film is partly evaporated and partly mixed. With further irradiation, in place of these crystals appear intermetallic phase inclusions up to several microns in size.

It is seen that in the presence of an alloying coating in the processes of changing the structure of the sample surface, short discrete pulses prevail, giving a contribution to energy at higher frequencies, which is in good agreement with [1,2]. The growth of high-frequency energy in the spectrum of the vibroacoustic signal is accompanied by an increase in the content of the intermetallic phase.

In order to effectively control the results of irradiation of various materials in an automated mode, a deterministic algorithm for processing vibroacoustic information has been developed that allows us to evaluate the quality of the results obtained in real time, despite a fairly limited set of diagnostic parameters, whose digital values nevertheless allow us to control the quality of the process and make a decision about its repetition or changing the initial parameters.

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