

MODELING OF PROCESSES REALIZING DURING COMBUSTION OF HIGH CALORIC THERMITE MIXTURES ON SURFACE OF ACTIVE METALLIC SUBSTRATE

Dmitrii Andreev, Vladimir Yuxhvid, Vladimir Sanin, Konstantin Shkadinsky

Institute of Structural Macrokinetics and Materials Science RAS, Russian Federation

ade@ism.ac.ru, yukh@ism.ac.ru, svn@ism.ac.ru, shkad@icp.ac.ru

Keywords: combustion wave, thermite mixture, high-temperature chemical reactions, composite materials, mathematical and experimental modeling

Summary: In the present study, we made an attempt to synthesize cast metal-matrix composites and simulate of deposition such coatings onto an active substrate starting from metal oxides an energy- and cost-effective technique of centrifugal metallothermic SHS [1].

This paper demonstrates task solving on theoretical and experimental study of the dynamics of combustion processes of thermite layered mixtures on surface of active metal substrates. In this work is considered a model system of combustion wave propagating in green mixture after ignition. As a rule the combustion temperature exceeds the melting temperature of all components of final products and metal substrate, therefore the combustion wave forms liquid-phase flows and chemical conversion of the two-phase melt where the oxide phase produces a continuous medium, and the metal (target) product is distributed in the form of droplets in it. After combustion the "hot" two-phase melt products comes into contact with the "cold" basis. In the system of melt-substrate runs a number of processes:

- intense heat of the "hot" layer of combustion products with the "cold" metal substrate, as a result of cooling of the product layer and heating the substrate; heating leads to melting and movement of the melting front deep foundations;
- gravitational separation of phases and the metal oxide layer in the combustion products leads to the formation of a product layer of the metal and the oxide phase is displaced in the upper layer [2];
- exothermic chemical interaction forming two-phase solution of the target metal melt with melt of active substrate.

Experimental model thermite mixture is a mixture of nickel oxide and aluminum, as an active substrate is titanium plate. The final result of the experiment is obtaining a three-layer composition: cast alloy (Ni–Ti) – titanium substrate and cast alumina. One of the most important for the practice results is possibility of obtaining good adhesion Ni–Ti compound with a titanium substrate and the way of lightweight multilayers composite material.

The reported study was supported by RFBR, research project № 15-03-01986.

References:

- [1] Yuxhvid V.I. High Temperature Liquid-Phase SHS Process: New Directions and Challenges. J. Non-Ferrous Metallurgy, 2006, no. 5, pp. 62–78.
- [2] D.E. Andreev, V.N. Sanin, V.I. Yuxhvid and D.Yu. Kovalev. Regular features of combustion of CaO₂/Al/Ti/Cr/B hybrid mixtures. Combustion, Explosion, and Shock Waves, 2011, vol. 47, no. 6, pp 671–676.