KINETICS OF REACTION TRABSFOMATIONS IN COMBUSTION WAVE FOR THE TITANIUM - MOLYBDEN – NITROGEN SYSTEM.

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Combustion synthesis (CS), also known as self-propagating high-temperature synthesis, is currently considered to be one of the efficient industrial methods for the production of different advanced materials including nanomaterials, alloys, refractory inorganic compounds and functional materials.

In this work, the peculiarities of filtration combustion are studied using Ti-Mo reaction systems. In addition, characteristics of the thermal wave structure are investigated during nonstationary combustion, and the mechanism of the structure formation of product is found.

The titanium-molybdenum-nitrogen system was selected due to the fact that the synthesis products of the system could be used as hardening coatings for equipment operating under extreme conditions. In addition, the results obtained are important for deep understanding the mechanisms of filtration combustion of metals. The experiments were conducted using the developed technique of dynamic pyrometry [1] and high-speed video recording.

According to the results obtained, the combustion of the mixture in nitrogen is conducted in the surface mode. This mode is characterized by the propagation of a reaction wave in a narrow near-surface layer of the sample followed by the penetration of combustion from the surface to the center, as can be seen from the increase in the glow intensity of the hole after the passage of a surface wave. The peculiarities of combustion observed are the presence of local reaction sources and the complex three-dimensional structure of the temperature field in the reaction wave. The measurements have shown that the maximum temperature of the surface wave outside the combustion source (T1) is 200 K lower than the temperature that is reached at the center of the sample (T2). This is explained by the effect of heat accumulation during nitrogen filtration in the central part of the sample. This fact corresponds to the observed fusion in the central part of the sample, where the temperature is 110 K higher than the melting point of titanium. The temperature of the surface combustion wave inside the combustion source exceeds the temperatures T1 and T2, which is explained by the known effects of heat accumulation in local combustion sources under the conditions of the thermal and chemical instability of nitriding reactions [3]. The time difference (Δt) for reaching the maximum temperature on the surface and inside the sample allows the linear propagation velocity to be estimated (0.9 mm/s).

The results demonstrated that all values of the maximum combustion temperatures are located within the «L-S» region as compared to the «Ti-Mo» state diagram [4,5]. The values obtained for the conversion degree of combustion products with variation of all experimental parameters are also located within the «L-S» region. When all the experimental points were plotted on the graph, for the case when the ratio of absorbed nitrogen to molybdenum was constant, it was found that, despite the variation of all experimental parameters, all the experimental points were located on 11 curves corresponding to 11 types of molybdenum nitrides. The ratio of molybdenum to titanium is always the ratio of integers (Mo_nN_m), i.e. the ratio of n to m corresponds to a number of stoichiometric formulas of molybdenum nitrides: from Mo_5N_3 to MoN_3.

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