MODELING OF THE COMBUSTION SYNTHESIS OF TITANIUM BASED COMPOSITE WITH DETAILED REACTION SCHEMA [1]

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Self-propagating high-temperature synthesis (SHS) is one of the methods of composite manufacturing based on titanium including titanium carbides, borides and silicides. However, this process is nonequilibrium process and it is not possible to predict the composition of the synthesized product due to the presence of a wide range of homogeneity on the phase diagrams of some systems. Therefore, the aim of this work is to develop a model and theoretical study the synthesis of the titanium-based composites in the combustion regime with detailed reaction kinetics.

The mathematical model of the process of the reaction initiation in the powder mixture of metal (*Ti*) and boron (*B*) is studied. The sample is a cylinder of radius *r* consisting of two layers of pressing powders (figure.1). We assume that layer *1* (igniter) is a stoichiometric mixture of Ti and Si powders and the thickness of this layer is *l*. The second layer of thickness *L* (reaction mixture) consists of the mixture of *Ti* and boron *C* powders. We assume also that titanium in the second mixture is presented in excess, so that it is not completely consumed in the reaction. We consider the chemical transformations in the first system are described by the total reactions scheme "reagent-reaction product"

$$5Ti + 3Si \rightarrow Ti_5Si_3$$

Four-step reaction proceed in the second layer

I. $Ti+2B \rightarrow TiB_2$; II. $Ti+B \rightarrow TiB$; III. $TiB+B \rightarrow TiB_2$; IV. $2TiB+TiB_2 \rightarrow Ti_3B_4$.

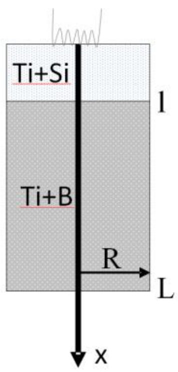

Fig. 1. Scheme of process

The heat losses to the environment by convection and thermal radiation are taken into account. Titanium excess consumes the heat and plays a role of an inert component. This is formally taken into account through the heat capacity. We consider the kinetic equations corresponding to the reaction with strong retardation of layer reaction product. The melting of the components was considered by taking into account the changing of effective heat capacity and density in the vicinity of the melting temperature.

Since the structure of the powder system is changing and is unknown at any time, we use the rule of the mixture to calculate the effective properties of initial substance and synthesized composite. The effective coefficient of thermal conductivity of the mixture was calculated similarly.

As calculations showed, an increase in excess titanium leads to some decrease in the temperature in the second reaction layer and to the reduction of the velocity of the reaction front propagation that qualitatively corresponds to the experiment. The stationary combustion wave in the igniter is not formed.

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