MODELING OF COMPOSITE SYNTESIS DURING SHS IN THE TI+C SYSTEM

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One of the methods of composite manufacturing based on titanium with inclusions of carbides borides and silicides is self-propagating high-temperature synthesis (SHS) or combustion synthesis. However, this process is nonequilibrium process and it is not possible to predict the composition of the synthesis product because of 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 of the synthesis of the *Ti-TiC* composite in the combustion regime.

It is known that, an igniter is usually used for difficult flammable non-gas systems to initiate the reaction, which is brought into contact with the ignition system. Ignition of the reaction mixture in this case is carried out by a combustion wave going along the igniter to the place of contact of the materials.

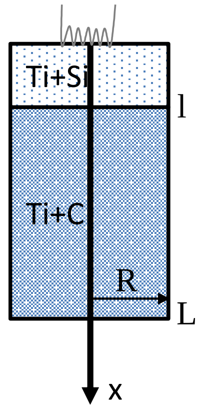

Figure 1. Scheme of process

A mathematical model of the process of initiation of the reaction in a powder mixture of a metal (*Ti*) and graphite (*C*) is considered. The sample is a cylinder of radius *r* consisting of two layers of powder fillings (figure 1). We assume that layer *1* (igniter) is a stoichiometric mixture of Ti and Si powders and the thickness of the layer is *l*. The second layer of thickness *L* (reaction mixture) is a mixture of *Ti* and carbon *C* (carbon black) powders. We assume that titanium in the second mixture is presented in excess, so that it is not completely consumed in the reaction. The fraction of titanium *Ti* that is not consumed in the reaction is η_e. We consider the chemical transformations in the system are described by the total reactions "reagent-reaction product" for the first layer

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

and second layer

$$Ti + C \rightarrow Ti + TiC\ .$$

As a result, we must obtain a composite of the form titanium-titanium carbide.

In the energy equation, we take into account the heat losses to the environment due to convection (if the synthesis is carried out in an inert gas atmosphere) and due to thermal radiation. Excess titanium consumes heat and it role an inert component. This is formally taken into account through the heat capacity. We consider the kinetic equation for conversation level corresponding to the reaction with strong retardation of layer reaction product. The melting of the component with the lowest melting point (Ti) was taken into account by changing the 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 composite properties. The effective coefficient of thermal conductivity of the mixture was calculated similarly.

As calculations showed, an increase in excess titanium η_e leads to a decrease in the temperature in the second reaction layer and a slowing of the propagation velocity of the reaction front, which qualitatively corresponds to the experiment. A stationary combustion wave in the igniter is not formed. The formation of a wave occurs almost instantaneously in the reaction mixture. The termination of the reaction after initiation is realized with the inhibition parameter of m = 25 and η_e =85%.

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