

EXPERIMENTAL STUDY OF THE PROCESS OF PRELIMINARY MECHANICAL ACTIVATION IN THE 5NB – 3SI SYSTEM AND ITS EFFECT ON THE SUBSEQUENT HIGH-TEMPERATURE SYNTHESIS OF SILICIDE

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Niobium silicides are used to create materials with the necessary properties, as heat-resistant alloys for high-temperature structures, for the production of additives for additive technologies [1, 2].

In this work, I study the effect of mechanical activation (MA) on the self-propagating high-temperature synthesis (SHS) of the Nb₅Si₃ phase in the mode of thermal explosion and layered combustion. The Nb-Si system is low-energy and it is impossible to conduct a SHS without any preliminary preparation [3 - 5].

Powders of Nb and Si – taken in the stoichiometric amounts to Nb₅Si₃ (Si – 15,36, Nb – 84,64 weight%) were processed in a high-energy planetary mill (60 g, mill/ball ratio 1 : 20) with water cooling. The green mixture were subjected to MA for time period $\tau = 0.30\text{--}120$ min under 1 atm of Ar. Thermal explosion in cylindrical pellets prepared from MA mixtures was performed in a 5-L closed reactor under Ar. Heating rate was 145 ± 25 deg/min. SHS in a layered mode was carried out under Ar in a constant-volume device. Thermocouple readings were used to determine the values of T_{cr} and T_{max} . Activated green mixtures and combustion products were characterized by SEM, optical metallography (Axiovert 200M), and XRD (DRON-UM).

Changes in the specific surface area and bulk density of the mechanoactivated mixtures after different time periods have been studied. Time intervals of MA after which it is possible to conduct SHS in a layered and thermal explosion modes have been found. The temperature characteristics of the SHS showed a decrease in T_{max} and T_{crit} with an increase in the MA time (Fig.1).

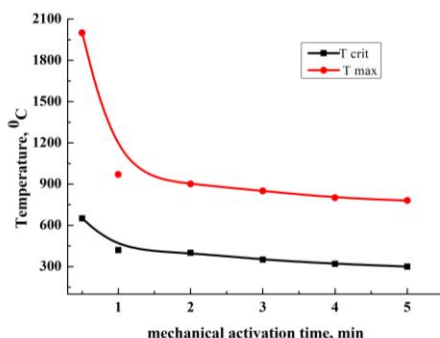


Figure 1. The dependence of the maximum and critical temperatures of a thermal explosion on the time of preliminary mechanical activation of a powder mixture of niobium and silicon

It is established that SHS in the thermal explosion mode of the Si–15,36 + Nb–84,64 weight % powder mixture can be carried out after 0.5 to 5 min MA, in the layered mode from 0.5 to 4 min MA. The temperature characteristics of self-propagating high-temperature synthesis decrease with an increase in the pre-treatment time. The synthesized material in the thermal explosion mode is single-phase, contains only a phase Nb₅Si₃.

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