OBTAINING OF MATRIX OF DISPERSION NUCLEAR FUEL BY SHS METHOD

Yurchenko M.D.[1,a]

[1]National Research Tomsk Polytechnic University, Tomsk, Russia
[a]mdy2@tpu.ru

Modern nuclear power engineering is an industry field that is developing rapidly. In the consequence of the increasing needs of mankind, there is a need to use new, high-quality and less expensive functional materials.

One of the most important elements in the nuclear industry is the fuel used. It is to him that the highest requirements must be established. The most important requirement is the high concentration of the fissile isotope to maintain the nuclear chain reaction. It is also important that the materials used in the fuel are radiation-resistant and retain their chemical, thermal and mechanical characteristics during long-term operation in a nuclear reactor. Also fuel connections should be characterized by high thermal conductivity to minimize thermal stresses and reduce the temperature gradient in the tablet, a high melting point that exceeds the operating temperature of the reactor facility, availability and cheapness, and mechanical strength.

Traditionally used ceramic nuclear fuel, represented by uranium dioxide, has a number of disadvantages, the main one of which is low thermal conductivity, which leads to thermal stresses in the volume of the tablet and cracking of the brittle ceramic at high temperatures.

Perspective replacement of ceramics can serve as a dispersive nuclear fuel (DNT), which is a matrix of inactive element with fuel particles dispersed into it [1]. A promising material for the matrix of dispersive nuclear fuel can serve intermetallic compounds, whose amazing properties have already manifested themselves in materials for space technology.

Intermetallic compounds can be obtained by economically advantageous method of self-propagating high-temperature synthesis (SHS). This method is based on the ability of some elements to enter into an exothermic reaction [2]. In itself, SHS does not require any sophisticated equipment, and it is also attractive for relatively low energy costs for the implementation of the reaction. Also it is possible to dilute the reagents with an inert additive, which can be fuel particles.

In this paper, the synthesis of the intermetallic matrix NiAl for DNT by the SHS method has been worked out and the effect of the addition of an inert additive on the thermodynamic parameters of the reaction has been studied.

When the content of the inert additive in the tablet is increased, the temperature peak of the reaction decreases. The reason for this is a decrease in the number of reacting particles, and, consequently, a decrease in the total released energy in the exothermic reaction.

But when reacting with a tablet containing 60% of an inert additive, deviations from the foregoing relationship are observed. This is due to the fact that there are too few reactive elements in the volume of the tablet, and therefore the reaction begins to proceed with an increase in the initiation temperature, which leads to an increase in the peak temperature.

It should be noted that when the mass fraction of the additive is on the order of 20-30%, the tablet overheats, as a result of which aluminum and nickel melts begin to form in volume, which leads to a change in the geometric shape and size of the tablet. A plurality of pores are formed, the compressed layers are separated. On the contrary, in the sintering of samples with an additive content of 50%, a low synthesis temperature is noted, which does not lead to negative consequences.

References

1. Алексеев С., Зайцев В., Толстоухов С. Дисперсионное ядерное топливо. – Litres, 2017/ – С. 5-20.

2. Амосов А. П., Боровинская И. П., Мержанов А. Г. Порошковая технология самораспространяющегося высокотемпературного синтеза материалов. – Машиностроение-1, 2007. – С. 7-12.