PROBLEMS OF SOLID-PHASE SYNTHESIS UNDER EXPLOSIVE LOADING

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At present, the processes connected with mechanical and physical and chemical transformations which occur when shock waves propagate through metals, minerals, polymers, and other solids attract close attention of researchers. Synthesis of new materials conducted under equilibrium conditions is practically exhausted. Perspectives are associated with the obtaining of metastable compounds under nonequilibrium conditions, and explosive loading provides great opportunities for this purpose. It should be noted that the potential of explosive loading has not been studied thoroughly yet, and so far this direction has not become a technology due to the lack of experimental data and numerical multicomponent medium models which can consider the cumulative effect of mechanical, chemical and physical processes and estimate the role of each factor. During explosive loading of recovery ampoules with reacting multicomponent mixtures, there is a significant energy release due to exothermic reactions, which, on the one hand, can lead to a self-sustaining propagation of chemical reactions in mixtures and, on the other hand, to the failure of ampoules, as well as to the complete fracture [1]. It is necessary to mention that the initiation and development of shock-induced reactions are determined not only by the temperatures reached but also by the dispersion and porosity of initial components. In addition, the initial dispersion of components can contribute to the fracture of the cylindrical ampoule.

In the work, the process of solid-phase synthesis was studied using aluminum-sulfur and aluminum-fluoroplast mixtures placed in a cylindrical ampoule under explosive loading on the basis of a mathematical multicomponent medium model developed to predict the behavior of reacting mixture, taking into account the porosity and dispersion of mixture components [2].

The analysis of numerical and experimental results allows us to conclude about the contribution of the porosity and dispersion of mixtures to the dynamics of shock wave propagation and the development of chemical reactions during solid-phase synthesis in cylindrical ampoules under explosive loading. During the propagation, a shock wave, reflected from the bottom of the ampoule in the form of a compression wave, encounters the shock wave propagating in the sample, which leads to a sharp increase in the pressure and the rate of chemical reactions in the low and middle part of the sample. It should be noted that the reaction in the high dispersion Al/S mixture is complete with the formation of aluminium sulfide (100%). Despite the sharp increase in pressure and temperature, not all the low dispersion mixture components react to form aluminium sulfide. The contribution of high pressures and temperatures is not sufficient for the complete reaction in the low dispersion mixture.

The experimental and numerical results have shown that the higher the initial dispersion and porosity of the mixture components, the more intensive the ampoule fracture. In some experiments, there was a complete fracture of the ampoule.

The experimental and numerical studies have revealed the problem connected with the fracture of ampoules containing reacting porous multicomponent mixtures under explosive loading, which urgently requires conducting the further studies to solve this problem.

REFERENCES

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