theoretical and experimental determination of shock wave properties for mixtures of high porosity materials
at megabar pressures

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Nonstationary behavior of mixtures of high porosity materials (MHPM) under shock-wave loading is of interest for many problems of modern science and practice. It is primarily the investigation of thermodynamic properties of matter in the region of the phase diagram, unachievable by shock compression of solid samples, along with the numerous tasks of explosive technology (shock-wave synthesis, dynamic compaction, explosion welding).

The study of the dynamic behavior of multi-component condensed matter usually deals with the mixtures of solid particles (powders), because of it’s simple fabrication. For the same reason the multicomponent powder (recently – nanopowder) mixtures are often used as raw material in explosive technology. The behavior of powder mixtures under shock compression is characterized by number of unique features (for example - microjet formation and thermal non-equilibrium). It requires an experimental study in conjunction with physical and mathematical simulation.

The information about shock-wave characteristics of MHPM, in particular the shock adiabats is required to predict the parameters of non-stationary wave processes, formed in MHPM.

Additive approximation [1] often used for the construction of shock adiabats of multi-component mixtures is valid in the absence of the thermal component of pressure. However, it increases with increasing porosity of the medium, and can’t be ignored in case if MHPM. Y.B.Zeldovich’s model of complete collapse of pores, does not allow to consider the presence of gas in the pores, at non-zero pressure. A more detailed description of deformation and collapse of pores is required to take gas into account.

Usually, the definition of shock-wave characteristics suggests a one-dimensional geometry. However, there are a number of works [2,3], which pay attention to the importance of multidimensional effects for the description of detonation and shock waves.

In this paper, we propose a multi-dimensional physical and mathematical model of unsteady compression of MHPM in shock wave in framework of one-speed equilibrium approximation. The possibility of formation of a cellular structure at the front of the shock wave was studied. The microjet formation in pores and thermal non-equilibrium of MHPM components were studied experementally. The cumulative generator of megabar pressures, used in experiments, is described in [4].

The theoretical and experimental shock-wave characteristics of mixtures of light and dense metals with substantially different Hugoniots: Al + Cu and Al + W were determined.

References

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