On the phase state of thin wire cores during fast electric explosions

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Topical issues of analysis of modern experiments with explosive wires in vacuum are discussed. The formation of long-living structure ascertained in the late nineties [1, 2] is demonstrated a much more complex than previously thought, manifestation of phase transitions in metals. However the scenarios of energy deposition in the form of a chain of *heating–melting–evaporation–ionization* covering all volume of substance are popular even today [3]. But this contradicts the fact of emergence of a wave of the unloading propagating from the surface deep into of metal. As a result, the cross-section of loading is divided into two parts in which processes proceed variously. In the outer part, where the magnetic field is important, an overheated liquid is formed and a phase explosion occurs. In the inner part, the thermodynamic pressure dominates general considerationwhich becomes small and even negative after the reflection of the wave from the axis [4]. The scenarios [3] are based on the fact that several atomization energies are deposited in the metal, from what the conclusion about a possibility of full evaporation of wire made of. However, according to the general analysis presented in the book [5] it can occur only at value of the entropy exceeding its value in a critical point. More thorough examination of the experimental data on explosion of silver wires also speaks about hasty of a conclusion about full evaporation of loading. Existence in products of explosion of a significant share of the condensed substance follows, in particular, from excessively strong dispersion of the probing laser radiation in a core. Besides, idea of full evaporation of a core is contradicted by stability and sharp borders of striations which formation, as a rule, accompanies explosion of wires from fusible materials [6]. The lack of total evaporation at high energy deposition is related to the features of the metal-dielectric transition, which occurs nonuniformly in different load regions. The report gives a qualitative interpretation of the processes with the rapid deposition of energy in the conductor. It is shown as the energy supply scale, it is more correctly to use the bond energy in a metal partly spent to atomize matter.

References

1. G.V. Ivanenkov, A.R. Mingaleev, S.A. Pikuz, T.A. Shelkovenko, W. Stepnievski, D.A. Hammer. JETP 1998, 87, 663.
2. S.A. Pikuz, G.V. Ivanenkov, T.A. Shelkovenko, D. Hammer. JETP Lett. 1999 69, 377.
3. G.S. Sarkisov, P.V. Sasorov, K.W. Struve, D.H. McDaniel. J. App. Phys. 2004, 96(3), p. 1634–1686.
4. S.I. Tkachenko, K.V. Khishchenko, V.S. Vorob’ev, P.R. Levashov, I.V. Lomonosov, V.E. Fortov. High Temperature 2001 39, 674.
5. Ya.B. Zel’dovich, Yu.P. Raizer. Physics of Shock Waves and High-Temperature Hydrodynamic Phenomena, Courier Corporation, 2012.
6. V.M. Romanova, A.R. Mingaleev, A.E. Ter-Oganesyan, T.A. Shelkovenko, S.A. Pikuz. Problems of atomic science and technology (PAST) 2013, 1(83), p. 284–286.