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High-temperature phase transformations. The properties of the phases and their equilibrium under shock loading.

EUGENE ZARETSKY, Ben-Gurion University of the Negev

Introducing the temperature as a variable parameter in shock wave experiments extends essentially the scope of these investigations. The influence of the temperature variations on either high strain rate elastic-plastic response of solids or parameters of the shock-induces phase transformations are not trivial and are not quite clear yet. The technique of VISAR-monitored planar impact experiments with the samples preheated up to 1400 K was developed and used for the studies of the effect of the preheating on the impact response and on the "dynamic" phase diagrams of pure metals (U, Ti, Fe, Co, Ag), and ionic compounds (KCl, KBr). The studies show that the increase of the shear strength of the shock-loaded metal with temperature (first reported by Kanel et al. 1996) is typical for pure FCC (Al, Ag, Cu) and some other (Sn, U) metals, and for the ionic crystals. In the metals with BCC lattice (Mo: Duffy and Ahrens 1994, Fe: Zaretsky 2009) such thermal hardening was not found. The abrupt strength anomalies (either yield or spall or both) were observed in a narrow vicinity of the temperature of any, polymorphic, magnetic, or melting, phase transformation. It was found that when a pure element approaches the phase boundary (the line of either first or second order phase transition) the result is a 50-100-% increase of the shear strength of the low-temperature phase. At the same time the presence of a small ($\sim$0.5 %) amount of impurities may lead to a five-fold decrease of the strength as it takes place in the vicinity of the Curie point of Ni. The same technique being applied to the study of the shear stress relaxation (elastic precursor decay) near the transformation line may be useful for understanding the mechanisms responsible of these anomalies.