Research of Ejecta Processes In Case Of Shock Wave Coming To a Metal Surface Using Electrophysical Facilities

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Summary: Realization of the studies of microdamages of the back surface with recovery of the specimens and micro fragments after the shock effect to conduct metallographic analysis will be discussed.

Introduction

Superposition of shock waves generated at the intensive shock-wave loading of the specimens may lead to a growth of perturbations in the regular motion of the specimen material and, in particular, to a growth of small-scale ejecta-forming instabilities of the free surface of the specimen.

The application of the liner systems driven by high current may have peculiarities related to inertia-free nature of magnetic field. At this it is possible to get a short-time loading and a possibility of recovery of the studied specimen material after the shock-wave loading for a detailed study of its damages [1].

Experimental Technique

The paper describes the setup of the experimental research of the small-scale ejecta-forming damages at the shock loading generated by the liner high-current system on the basis of a capacitor laboratory facility "Cascade". The capacity of the bank of the "Cascade" facility is 492 μF, the inductance of the discharge circuit including the unit with the driven liner-impactor is on the order of 60 nH, time of current rise to the maximum is ~ 6-8 μs. The energy stored in the capacitors is up to 600 kJ. At the bank charge voltage of 40 kV the current amplitude is ~ 4 MA.

The magnetic pressure driving the liner depends on the current linear density and respectively on the width of the liner part the current flows through. To provide the electromagnetic drive of the liner-impactor, the design scheme has been used that ensures the increase of the current density. The cable lines from the capacitor sections are attached to the coaxial current collector. The pipe coaxial electrodes, 200 mm in diameter, of the coaxial current collector are cut in the form of a feather along the opposing helix lines for a continuous concentration of current at one of the sides the liner is located at. The width and length of the liner-impactor is 40 mm, the amplitude of the driving magnetic pressure is $2{,}5\ldots3{,}5\cdot10^{9}$ Pa. The liner is made two-layered. The liner comprises a well-conducting layer (several tens of a millimeter of aluminum) and an electrically non-exploded steel layer with low conductivity and thickness changing from 0,1 mm to 2 mm for a variation of duration of the shock effect within the range of 10^{-7}-10^{-6} s. The liner-impactor achieves the velocity of 2…2,5 km/s on the acceleration length of 10 mm equal to ten thicknesses of the impactor.

The specific feature of measurements is that along with such traditional techniques as piezosensors and X-raying a smooth deceleration of the specimen and of the chipping-off particles with the use of a porous fine-dispersed soluble medium NaCl is ensured (Figure 1). After dissolving of the catching medium the structural changes in the specimen and the physical condition of the chipped-off particles, including the dust-like ones, is determined.

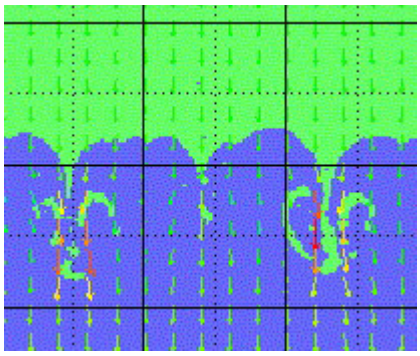

Figure 1 – Computer simulation of deceleration of a specimen and of a fragment in a fine-dispersed medium NaCl.

This gives additional possibility for a detailed study of the change in the specimen and of the physical condition of the chipping-off particles after an intensive shock loading.

References

[1] P.V. Duday, A.V. Ivanovskiy, O.A.Tyupanova et al., "Study of Aluminum ALCAN Spall Fracture and Recollection Using an Explosive Magnetic Pulsed Power Source on the Basis of a Helical EMG." Results of R-Damage 0-7 Series of Experiments, the 13th International Conference on Megagauss Magnetic Field Generation and Related Topics Suzhou, China, July 06-10, (2010).