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STUDY OF THE MULTI-COMPONENT COMPOSITE MATERIALS BEHAVIOR UNDER HIGH-CURRENT RELATIVISTIC ELECTRON BEAM IMPACT *)

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In concerned with the active introduction of composite materials in various fields of science and technology, in recent years the behavior of such materials and their individual components under extreme pulse loads and, in particular, under irradiation with high-current beams of relativistic electrons has been actively studied [1-3]. The intensity of irradiation, the depth of electron penetration, the magnitude of spallation strength and shock adiabats largely determine the formation of various types of damage in composite materials: ablation of the irradiated surface, the formation of spallation on the back side of the sample, as well as through or radially oriented cracks. The ability to undergo large volumetric changes under extreme influences on such a class of polymer composite materials as syntactic foams allows us to study in detail the features of their ablation and the influence of the chemical properties of the syntactic foam components. In this work, syntactic foams based on phenylsilsesquioxane and butadiene nitrile elastomers, which differ in the energy of intermolecular interaction of macromolecules, were chosen as the object of study.

The experiments were carried out on a high-current electron accelerator "Squid" at voltages in the diode gap of 240-300 kV, a current of 20-45 kA and a pulse duration of 100-150 ns [4]. The dynamics of the plasma arising during ablation of the target surface was studied using laser shadow photography. A pulsed laser on yttrium orthoaluminate with neodymium (λ_1=1079 nm), manufactured at the Scientific and Technical Center of the UP RAS, was used as a source of probing radiation. The laser operated in the free-running mode with intracavity conversion of radiation λ1 into the second harmonic (λ_2=540 nm). Output parameters of radiation pulses (540 nm, 90 mJ, 300 μs, 7 mrad). An SFER-6 electro-optical camera operating in chronographic mode was used as a recorder [5].

It was demonstrated that the nature of target ablation is to a significant extent determined by the chemical characteristics of the irradiated material, but is also largely related to the degree of focusing of the electron beam on the target.

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References

[1]. Milekhin Y.M., Sadovnichii D.N et al Doklady Chemistry. 2019. V. 487. № 1. P. 184-187.
[2]. Sadovnichii D.N, Milekhin Y.M. et al Russian Journal of Appl. Chemistry. 2022. V. 95. № 1. P. 88-99.
[3]. Sadovnichii D.N, Milekhin Y.M. et al Russian Chemical Bulletin, Vol. 72, No. 9, pp. 2048—2059, September, 2023
[4]. Demidov B.A., Ivkin M.B., Petrov V.A., Fanchenko S.D. // Atomic Energy. 1979.Vol. 46. V. 2.P. 101–116.
[5]. Kazakov E.D, Kalinin Yu.G., Krutikov D.I. et al // Plasma Physics. 2021.Vol. 47. N 8.P. 716 - 727.

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