AD-A191 472 SPALLATION AND DYNAMIC FRACTURE AS AN EFFECT OF LASER-INDUCED SHOCK WAVES(U) ISRAEL ATOMIC ENERGY COMMISSION YAVNE SOREQ NUCLEAR RESEARCH C.. 1/1

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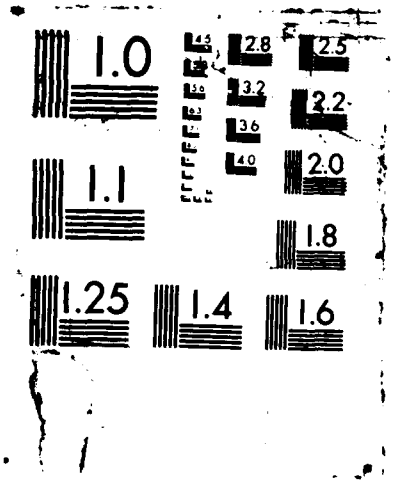
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SPALLATION AND DYNAMIC FRACTURE AS AN EFFECT OF LASER-INDUCED SHOCK-WAVES

First Periodic Report

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Spallation and Dynamic Fracture as an Effect of

Laser-Induced Shock Waves

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The first two months of the present contract were devoted to preparatory work in the mainstream of the research. In particular, our interest was focussed on three activities:

1. Search for laboratories which produce and sell targets of composite materials which are appropriate for the suggested research.

2. We have carried out some preliminary experiments to obtain information about the values of the damage threshold in composite materials as well as a qualitative description of the damage mechanism in these materials.

3. Tentative work plan for the first year was set up.

1. Target Materials

A systematic search was carried out to identify producers of composite materials with predefined specifications . We identified in Israel producers of graphite epoxy, two-dimensional and three-dimensional carbon-carbon composites who have the facilities to supply targets with thickness below 500μm. It appears that the specifications of our targets pose special difficulties for their production , nevertheless the producers believe that these targets can be supplied. At present, the producers of the 2D and 3D C-C composites

are checking in more detail the possibility of making targets which meet our specifications both as to dimensions and the material properties (specific gravity and fiber orientation).

2. Experiments with graphite epoxy targets.

Graphite - epoxy targets of 450 μm thickness were irradiated with Nd: glass laser pulses (= 1.06μm) of 3.5 nsec width. The aim of these preliminary experiments was to get some initial information about the damage threshold and mechanism in composite materials. The targets were composed of three layers of graphite fibers reinforced by epoxy. The fiber orientation in neighboring layers is perpendicular to each other. A thin protective cloth covers the front surface (facing the laser) of the target.

The targets were irradiated by 80 J energy laser pulses focussed down to spots having diameters of 0.1 and 1.0 mm, thereby producing power densities on the target of 3.10^{14} and 3.10^{12} W/cm^2 respectively. Figures 1-5 show the results. Figure 1 shows the front surface damage produced by the laser shots. The burnthrough of the cloth and the damage to the front-surface fibers are clearly seen.

In Fig.2 the backsurface damage is shown . As can be seen from the picture, the principal damage is the detachment of the fibers from the target along their original direction. While the transverse dimensions of the damage are of the order of the laser induced shock wave diameter , i.e about 1mm, the longitudinal dimensions are by a factor of 20 longer and extend to about 15-20 mm in length. This

behaviour is substantially different from laser induced damage in metals, where the area of the backsurface damage was about the same as that of the incoming shock wave. In figures 3 and 4 the enlarged details of the backsurface damage are shown, as photographed by SEM (Scanning Electron Microscope). These photographs give information of the general properties of the damage. The damage in Fig. 3 is produced by 3.10^{12} W/cm^2 irradiation intensity, whereas in Fig. 4 the intensity was 3.10^{14} W/cm^2. The quantitative difference between the two damage patterns requires further analysis .Finally, in fig. 5 we show the target after sectioning. It is interesting to note that the nature of the backsurface damage is characteristic of that produced by backreflected tensile waves from the backsurface, namely, to spallation.

3. Future Plans

The experiments described in section 2 will serve as guideline for the mainstream of the suggested research.

Experiments will be carried out in accordance with the SOW in the original proposal. As a first step, targets of graphite-epoxy as well as 2D and 3D carbon-carbon composites will be irradiated by our laser beam to find the threshold laser intensity for backsurface damage. The targets will be sectioned to evaluate the nature of the damage on the backsurface and to search for possible internal damage, in a manner similar to the experiments presented in this report.

Subsequentally, we intend to measure threshold energies versus target parameters such as specific gravity or fiber orientation. The order and timing of these experiments will be decided upon the receipt of the targets.

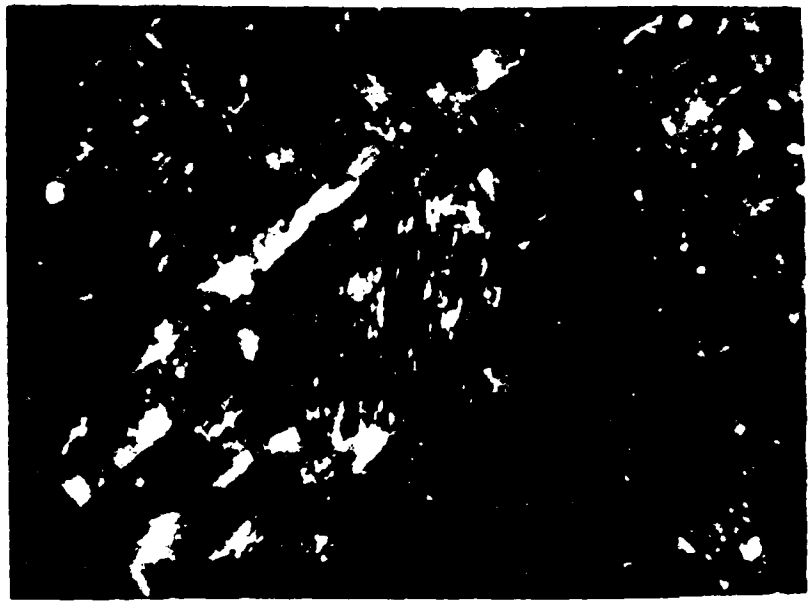

Fig. 1

Fig. 2

Fig. 3

Fig. 4

Fig.5

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