which is followed by the plastic wave. The time difference between the two peaks is consistent with the assumption that the precursor pulse is moving at the elastic dilatational sound velocity and its slower-moving plastic counterpart has a velocity approximately given by the bulk sound speed. Based on the pressure profiles shown in Fig. 3 and the attenuation curves in Fig. 2, it is concluded that the stress wave attenuation through the first 0.05—0.06 cm of material is governed primarily by hydrodynamic effects, and microstructural damping effects become increasingly important thereafter. By the time the wave has passed through 0.3 cm of material it consists almost entirely of an elastic component which is only weakly attenuated as it propagates through additional material. Since the magnitude of this wave is not expected to be a sensitive function of the laser fluence incident on the front surface of the sample, the 0.3-cm-pressure measurement given in Table I and plotted in Fig. 3 was not scaled upward to account for the lower value of laser fluence compared to the other measurements.

Additional computer studies were made in order to investigate the effect of laser fluence, laser energy deposition time, and different overlay configurations on the magnitude and shape of the stress wave generated at the sample's front surface. At the lower laser fluences the code predictions essentially confirmed the results of earlier work by Anderholm[7] who showed that the peak pressure increased approximately as the square root of the laser fluence. However, the code showed this relation did not hold at the higher laser fluences where reflection of light by the blowoff plasma had a dominant effect on both the size and duration of the laser-induced stress wave. Energy loss by reradiation was found to be negligibly small for all of the laser environments studied.

The shape of the stress wave near the sample's front surface was found to be closely related to the time profile of the laser pulse. By lengthening the laser pulse it was possible to lengthen the pressure pulse. The code predicts that pressure pulses several hundred nanoseconds in width can be generated in solids if the appropriate laser environment is incident on its surface.

A final consideration in the computer analysis was an investigation of the effect of placing different thin metal films between the sample surface and transparent overlay. It appeared that the laser-induced peak pressures could be increased by selecting a material with a low heat of vaporization thereby reducing the unproductive use of laser energy to vaporize the material. Lead, which is a readily available metal and has a low heat of vaporization, was initially selected for this study. The presence of the lead overlay did provide about a 20% increase in the peak pressure at a laser fluence of 30 J/cm^2. However, at higher fluences the effect of the lead diminished and actually resulted in lower predicted peak pressures than the bare Fe-3 wt% Si surface. This was attributed to the higher degree of ionization present in the lead configuration which both lowered the threshold for the onset of laser light reflection and resulted in a larger fraction of the laser energy being converted into internal energy of the blowoff material. In order to reduce the degree of ionization while preserving the advantageous characteristics of a low sublimation energy material, a zinc overlay was investigated. The results of these calculations were very encouraging and pressures up to 150 kbar were predicted at a laser fluence of 60 J/cm^2.

In summary, the experimental results and code predictions confirm our earlier suppositions concerning the magnitude of the laser-induced stress waves. In addition, code calculations demonstrate that significant improvements in both the size and duration of the stress waves can be achieved by appropriate tailoring of the laser environment and sample surface overlay configuration. Experimental studies to confirm these predictions are presently being completed and will be reported at a later date. The particular choice for the iron-base alloy (Fe-3 wt% Si) used in this study was based on the fact that the shock-induced microstructural changes could be quantitatively analyzed by a well-characterized etch-pitting technique.[18] Although the results of this study are still being evaluated, it is evident from examination of the spatial distribution of the stress-wave-induced microstructural changes that radial release waves and stress wave reverberation from sample boundaries play an important role in the final state of the the material's substructure.

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