A laser driven flyer plate utilizing an optical fiber connected to a laser. The end of the optical fiber has a layer of carbon and a metal layer deposited onto it. The carbon layer provides the laser induced plasma which is superior to the plasma produced from most metals. The carbon layer plasma is capable of providing a flatter flyer plate, converting more of the laser energy to driving plasma, promoting a higher flyer plate acceleration, and providing a more uniform pulse behind the plate. In another embodiment, the laser is in optical communication with a substrate onto which a layer of carbon and a layer of metal have been deposited.
Fig. 1
CARBON-ASSISTED FLYER PLATES

The invention is a result of a contract with the Department of Energy (Contract No. W-7405-ENG-36).

BACKGROUND OF THE INVENTION

The present invention generally relates to flyer plates and, more specifically, to laser initiated flyer plates having multiple layers of material.

Flyer plates have been used for detonating explosives since their invention in the late 1960s. Originally, these flyer plates were electrically operated, utilizing an electrically produced plasma to accelerate the plate. It was subsequently discovered, after development of the laser, that laser induced plasmas could be used for plate acceleration.

Current laser initiated explosives or energetic materials operate by either of two methods: thermal runaway, or exploding a metal film to generate a high temperature in a manner similar to an exploding bridgewire. The first of these, thermal runaway, is a slow process requiring a period ranging from several hundred microseconds to several milliseconds to attain plate acceleration. Additionally, thermal runaway requires the addition of undesirable additives to the energetic material in order to reduce energy and thermal requirements to a practical level.

The second, the exploding metal film, is effective for detonation of low density (≤0.5 Theoretical Maximum Density-TMD) secondary explosives, but is not effective to produce detonation at reasonable energies for high density (≥0.9 TMD) explosives.

There is currently significant interest in inertial confinement fusion, where large amounts of energy are directed at a sphere of fuel. Although laser beams are now being used in testing, it is conceivable that multiple flyer plates could be launched at the fuel sphere, or that an imploding flyer plate could be on the fuel sphere. The flyer plate may reduce or eliminate the pre-heat problem with large, high power lasers. The invention also finds application in one-dimensional impact of materials, as embodied and broadly described herein, the apparatus and methods described herein, illustrate the embodiments of the present invention and, together with the description, serve to explain the principles of the invention. In the drawings:

FIG. 1 is a cross-sectional view of an embodiment of the invention.

SUMMARY OF THE INVENTION

To achieve the foregoing and other objects, and in accordance with the purposes of the present invention, as embodied and broadly described herein, the apparatus of the present invention comprises a laser with an optical fiber having proximal and distal ends, having its proximal end connected to the laser. A layer of carbon is deposited onto the distal end of the optical fiber, and a metal layer is deposited onto the layer of carbon.

BRIEF DESCRIPTION OF THE DRAWINGS

The accompanying drawings, which are incorporated in and form a part of the specification, illustrate the embodiments of the present invention and, together with the description, serve to explain the principles of the invention. In the drawings:

FIG. 1 is a cross-sectional view of an embodiment of the present invention, in which an optical fiber has its proximal end connected to a laser and has carbon and metallic layers deposited on its distal end.

FIG. 2 is a cross-sectional view of another embodiment of the present invention in which a substrate is illuminated by a laser beam, and the substrate has layers of carbon and metal deposited onto it.

DETAILED DESCRIPTION

The present invention provides apparatus for the improved launching of flyer plates either from the end of an optical fiber, or from a substrate, in which a thin layer of carbon is deposited onto the fiber end or substrate and the metal layer is deposited over the carbon layer. This employment of a layer of carbon between fiber end or substrate, and the metal layer provides significant benefits for a launched plate.

The invention can be most easily understood through reference to FIG. 1. Here, a cross-sectional view of optical fiber 12, connected to laser 10, is illustrated.
allowing higher acceleration. Plasma created from carbon layer 14 is light and expands more rapidly in all directions than most metals, allowing it to equalize pressure. Carbon layer 14 also converts more of the energy from laser 10 into plasma than most metals because of the low sound speed of carbon plasma created by laser 10. In launchings of flyer plates 16, using carbon layer 14 in accordance with the present invention, flyer plate 16o quickly accelerated to a terminal velocity of approximately 3 Km/sec. With the launch of flyer plates lacking carbon layer 14, a terminal velocity of only approximately 2 Km/sec was achieved after a significantly longer acceleration period.

The present invention fulfills a need to launch a flyer plate in a much simpler and more versatile manner as compared to methods known in the art. Insertion of carbon layer 14 provides several major functions which are beneficial to the launch of flyer plate 16o from metal layer 16. The first is that the carbon plasma created by laser 10 has a sound speed higher than most metals, allowing it to equalize pressure gradients across the diameter of the flyer plate 16o more rapidly than a metal plasma. Another function is that carbon layer 14 converts more of the energy from laser 10 into a plasma than most metals because of the low reflection/adsorption ratio of carbon. Additionally, the plasma created from carbon layer 14 is light, and expands more rapidly in all directions than most metals, allowing higher acceleration.

What is claimed is:
1. A laser driven flyer plate comprising:
a laser;
an optical fiber having proximal and distal ends, said proximal end being connected to said laser;
a layer of carbon deposited onto said distal end of said optical fiber; and
a metal layer deposited onto said layer of carbon.
2. The laser driven flyer plate as described in claim 1, wherein said metal layer comprises aluminum.
3. The laser driven flyer plate as described in claim 1, wherein said laser has an output power of between 20-300 mJ in pulse durations of approximately 5-30 nsec.
4. The laser driven flyer plate as described in claim 1, wherein said metal layer is deposited on said layer of carbon by physical vapor deposition.
5. A laser driven flyer plate comprising:
a laser;
a substrate in optical communication with said laser;
a layer of carbon deposited onto said substrate; and
a metal layer deposited onto said layer of carbon.
6. The laser driven flyer plate as described in claim 5, wherein said metal layer comprises aluminum.
7. The laser driven flyer plate as described in claim 5, wherein said laser has an output power of between 20-300 mJ in pulse durations of approximately 5-30 nsec.
8. The laser driven flyer plate as described in claim 5, wherein said metal layer is deposited onto said layer of carbon by physical vapor deposition.

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