ELECTRO - OPTICAL SYSTEM FOR STUDIES
OF
TRANSIENT EVENTS

C. E. Canada

DEVELOPMENT DIVISION

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An electro-optical system assembled for studies of self-luminous events is described. Representative data obtained to date are included, and possible future applications are cited.

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Section V

ELECTRO - OPTICAL SYSTEM FOR STUDIES OF TRANSIENT EVENTS

ABSTRACT

An electro-optical system assembled for studies of self-luminous events is described.

The system, primarily designed to support LLL and SLA investigations of flyer and exploding wire assemblies, provides time-correlated optical and electrical observations over the functional life of the two self-luminous assemblies.

Representative results are listed.

INTRODUCTION

An electro-optical system, suitable for studies of transient events, has been used for studies of exploding bridge wires (EBW) and flyer assemblies. It should prove useful in future investigations of luminous or nonluminous phenomena such as exploding foils, spall, surface structure, etc.

A block diagram showing equipment arrangement used for work performed to date, is shown in Fig. 1.

The laser, ground glass diffuser, bandwidth filter, and single-frame camera provide reflected light information concerning the unit under test. The laser provides an intense, 20 nsec duration light pulse centered at $6943\text{\AA}$. Coherence of the light field and thereby the inherent speckle pattern is reduced by the ground glass plate. Film exposure due either to self-light or unwanted ambient light is eliminated by the $10\text{\AA}$ bandwidth filter centered at the laser's wavelength.

The Kerr Cell/camera assembly provides information concerning luminosity characteristics of the unit under test.

Both reflected and self-light information are gathered on one optical axis by means of the beam-splitter. The use of one optical axis permitted more accurate correlation between surface structure and luminosity characteristics.

The streak or framing camera and shadowgraphic lighting system provide conventional distance-time histories.

Also included, but not shown in Fig. 1, is instrumentation for monitoring current and voltage histories.

Time-correlation between single-frame and electrical records obtained from adding singles derived from laser illumination and the Kerr Cell trigger circuit, to current and voltage traces.

Time-correlation between streak and single-frame records obtained from directing part of the laser illumination to streak camera.

REPRESENTATIVE RESULTS

EBW'S

Preliminary work has been done to characterize EBW's during their burst phases. Figs. 2 and 3 illustrate data obtained for 1.5 mils diameter by 40 mils, gold EBW's.

Fig. 2 indicates differences in EBW expansion rates and surface features due to ambient environment. A pre-shot-still of the EBW is shown on the left. The photograph in the center shows an EBW tested in air while that on the right shows an EBW tested in a transparent liquid having a density of 1.79 g/cm^3 . Both exposures were taken 65 nsec after peak voltage.

Fig. 3 is a self-light record taken approximately 5 nsec before peak voltage of an EBW exploded in the air. Shown are a pre-still (left) and a test record (right). The test record is a double-exposure in that the self-light exposure is superimposed on a pre-still exposure. Double exposures were taken so that luminous patterns could be correlated with initial position. As may be seen a luminous sheath surrounds the wire at the time of exposure.

FLYER ASSEMBLIES

Fig. 4 illustrates results for surface characterizations. Photographs shown are from a mylar flyer assembly. The flyer, initially in contact with an aluminum foil, achieves velocity when the foil explodes. The record on the left is a pre-still. The center record is a reflected-light and that on the right is a self-light photograph. Exposure times relative to peak voltage are listed under the photographs.

Records such as the ones shown were used to investigate burst characteristics, surface integrities and surface profiles.

CONCLUSIONS

The intent of this report is for informative purposes. Although the system described herein evolved for support studies of specific test units, it should prove useful in studies of luminous or non-luminous phenomena such as explosive detonation, exploding foils, spall, surface disturbances due to shock waves, etc.

1. Laser, Q-Switched Ruby, 175 Mwatts
2. Direction of laser illumination
3. Ground glass diffuser
4. EBW shadowgraphic lighting
5. Direction of EBW light
6. Test Device
7. Streak or framing camera
(Eastman Kodak, Tri-X film)
8. Beam Splitter (25% transmitted and
75% Reflected)
9. 10 Å bandwidth filter
10. Single Frame Camera
(Eastman Kodak 2476 film)
11. Kerr Cell, 20 nsec exposure
12. Single frame camera (Polaroid 3000 film)

Fig. 1. General Arrangement of Diagnostic Apparatus

Pre-Still

Air

Liquid

Fig. 2. Differences in EBW Expansion Rates and Surface Features Due to Ambient Environment

Pre-Still

Self-Light

Fig. 3. Self-Light Record (Right) of an EBW Taken Approximately 5 nsec Prior to Voltage Maximum

Pre-Still

Reflected Light
Time: + 86 nsec

Self-Light
Time: + 86 nsec

Fig. 4. Characterization of Mylar Flyer Assemblies. Times Listed are Relative to Peak Voltage.