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Lab. Project 5046-3 Part 32
Final Report
NS 081-001

AW-7

MATERIAL LABORATORY

NEW YORK NAVAL SHIPYARD
BROOKLYN 1, N. Y.

TECHNICAL REPORT

DEPARTMENT OF THE NAVY
BUREAU OF SHIPS

[redacted]

S E C U R I T Y I N F O R M A T I O N

CRITICAL THERMAL ENERGIES

of

DOPED FABRICS

Submitted by

THE STRATEGIC AIR COMMAND
Department of the Air Force

L. Banet
J. Bracciaventi

Lab. Project 5046-3, Part 32
Final Report
NS 081-001
Technical Objective AW-7
AFSWP-388
26 June 1953

Optics and Nucleonics Branch
J.M. McGREEVY, Head

Superintending Engineer
G. J. DASHEFSKY

The Director
CAPT. H. T. KOONCE, USN

MATERIAL LABORATORY
New York Naval Shipyard
Brooklyn 1, New York

S E C U R I T Y I N F O R M A T I O N

[redacted]

Lab. Project 5046-3, Part 32
Final Report

ABSTRACT

For the purpose of evaluating the resistance of doped fabrics to the thermal radiation of atomic explosions, the critical energies of several doped fabric assemblies, submitted by the Strategic Air Command, U.S. Air Force, were determined by exposing the materials to the laboratory carbon-arc source of thermal radiation and examining the consequent damage. The exposures were applied by means of a carbon-arc source which furnished a maximum irradiance of 85 cal/cm^2/sec in the central area of the specimens if no absorbing screens were employed. However, for a better approximation of the laboratory exposure time to that in the field, absorbing screens were employed, giving effective exposure times in the range between 0.3 and 0.6 second. The methods of exposure and evaluation of the effective damage are indicated. It was found that for exposure times of approximately 300 to 600 milliseconds, the doped fabrics suffered complete destruction at radiant exposures ranging from 1.8 to 35 cal/cm^2, depending on the assembly exposed. Acetate butyrate dope assemblies are considerably more resistant to thermal radiation than cellulose nitrate assemblies.

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Final Report

Ref: (a) COMNYKNAVSHIPYD ltr C-S99/L5, Ser C-960-92 of 14 Mar 1950
(b) BUSHIPS restr spdltr S99-(0)(348), Ser 348-75 of 6 Apr 1950

Encl: (1) Critical Thermal Energies of Doped Fabrics

AUTHORITY

1. This investigation is part of the program originally proposed by reference (a) and formally authorized by reference (b). The general Thermal Radiation Program is under the supervision of the Armed Forces Special Weapons Project.

INTRODUCTION

2. As part of its general program on the effects of the thermal radiation of atomic explosions on materials, the Naval Material Laboratory is evaluating the characteristics, under exposure to high-intensity thermal radiation, of the various materials of particular interest to the several agencies of the Department of Defense. As data become available, these findings are published. In this report, the critical thermal energies of doped fabrics, submitted by the Strategic Air Command, U.S. Air Force, are indicated.

EQUIPMENT AND METHODS OF EXPOSURE

3. The critical thermal energies of the doped fabrics were determined, employing the Material Laboratory carbon-arc source of thermal radiation (Bibliography 1,2,3,4). The source consists of an 11-mm carbon arc, mounted at the focus of a mirror which collimates the emitted energy. A second mirror, which is mounted coaxially at a distance of 12 feet from the collimator, condenses the radiation to the mirror's focus. Gradations of thermal damage are obtained by varying the effective exposure time by accelerating a sample, 1x8 inches in surface dimensions, moving transversely through the focus. The exposure of the doped fabric specimens was made by fastening the fabrics to glass melamine blocks, provided with cut-outs in the central area to furnish an air background. In order to reduce the propagation of flame during the exposures and in order to secure the specimens to the glass melamine block, a glass silicone mask with several stops was used over the fabrics.

RESULTS

4. The critical thermal energies of the doped fabrics submitted by the Strategic Air Command were defined as those which produce certain characteristic reproducible effects on the materials, such as destruction, blistering or

ignition. The exposures were made through use of a carbon-arc source which furnished a maximum of 85cal/cm^2/sec in the central area of the specimens, if no absorbing screens were employed. However, for a better approximation of the laboratory exposure time to that obtained in the field, absorbing screens were employed, giving effective exposure times in the range from 0.3 to 0.6 seconds. The critical energies are shown in Enclosure (1).

5. It may be noted that the laboratory exposures have been produced under highly controlled conditions and, as a rule, give results which can be reproduced very well. However, for several reasons, one must use the data of Enclosure (1) with caution. The effects to be observed on material samples frequently remain unchanged over a considerable range of exposures. Since the surface effects are not gradated sufficiently for refined evaluations, only the initial stages, have been recorded. The effects on material surfaces are influenced by such factors as mounting, uniformity of material, atmospheric conditions and moisture content. Differences in density, absorption coefficient, chemical composition and particle size are responsible for the variations in effects which may be observed from area to area on the same material. Liquids and gases form during exposure to thermal radiation, even in a period of less than one second, thereby affecting the amount of thermal radiation incident on and absorbed by the surface.

It was noted that the rate of flame propagation was considerably slower on all specimens which did not contain cellulose nitrate dopes. Furthermore, when ignited, it was not possible to extinguish the specimens containing cellulose nitrate dopes, while specimens with acetate butyrate dopes could be extinguished without destruction of the base fabric.

SUMMARY

6. The results of this investigation indicate that upon exposure to the Laboratory carbon-arc source of high-intensity thermal radiation, the doped fabrics, submitted by the Strategic Air Command, suffered destruction by ignition at radiant energy values ranging from 1.8 to 35 cal/cm^2, depending upon the fabric exposed.

The assemblies employing acetate butyrate dope are considerably more resistant to radiation than the assemblies with cellulose nitrate dope. Within these two groups, the assemblies with white surfaces showed marked higher resistance than the non-white assemblies.

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Approved:

H. T. Koonce

H. T. KOONCE, CAPTAIN, USN
The Director

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Critical Thermal Energy Values of Doped Fabrics

Submitted by the

Strategic Air Command

(Exposure times - 300 to 600 Milliseconds)

No.	Material and Treatment	Description of Effect	Critical Energy cal/cm^2
1	Black cellulose nitrate dope(MIL-D-5554) and cellulose nitrate thinner (MIL-T-6094A) on cotton (MIL-C-5646)	Coating breaks into propagating flame which ignites and destroys the fabric	1.8-2.2
2	Aluminized cellulose nitrate dope(MIL-C-5553) and cellulose nitrate thinner(MIL-T-6094) on cotton(MIL-C-5646)	Coating breaks into propagating flame which ignites and destroys the fabric	3.6-4.2
3	White cellulose nitrate dope(MIL-D-5554) and cellulose nitrate thinner (MIL-T-6094A) on cotton (MIL-C-5646)	Coating breaks into propagating flame which ignites and destroys the fabric	7.1-8.7
4	White Dulux enamel, air dry(#83-508,2 coats) on cellulose nitrate dope (MIL-D-5553 and MIL-D-5552) with Aluminum TT-A-468	Enamel blisters and discolors	7.9
		Enamel breaks into propagating flame which ignites and destroys the fabric	12-20
5	White Dulux enamel(#85-805, 2 coats) over cellulose nitrate dope (MIL-D-5553) on cotton (MIL-C-5646)	Enamel blisters and discolors	13
		Enamel breaks into a propagating flame which ignites and destroys the fabric	16-19

No.	Material and Treatment	Description of Effect	Critical Energy cal/cm^2
6	2 coats of white cellulose acetate butyrate dope (#2651) over 2 coats of clear cellulose nitrate(MIL-D-5552), pigmented with aluminum TT-A-4612 over 5 coats of clear cellulose nitrate dope (MIL-D-5553) on cotton (MIL-C-5646)	Surface blisters and turns dull	15
		Coatings break into a propagating flame which ignites and destroys the fabric	17
7	2 coats of clear cellulose acetate butyrate dope (2650), pigmented with aluminum TT-A-4612, over 5 coats of clear cellulose acetate butyrate dope(#2650) on cotton (MIL-C-5646)	Surface blisters and turns dull	3.1-3.3
		Fabric exposed, after destruction of coating	8.5-9.1
		Fabric destroyed by a slowly propagating flame	20
8	2 coats of white cellulose acetate butyrate dope (2651) over 5 coats of clear cellulose acetate butyrate dope (2650) on cotton MIL-C-5646	Surface blisters and turns dull	18-19
		Coating flames during exposure without propagation	31
		Fabric destroyed by slowly propagating flame	35

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