Lawrence Livermore Laboratory

ENERGY DEPOSITION IN TATB BY
ELECTRONS AT 50 AND 100 MeV

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Since energy deposition by electron beam is almost instantaneous, deposition profiles can be used to effectively calculate the impulse delivered by the electron energy deposition within a material. Electron deposition also produces thermal effects that can sensitize certain targets. These two factors, along with the fact that high explosives will thermally or shock initiate, leads to interest in the effects produced by impinging electron beams on high explosives.¹

The following calculations were made for a .1 cm² electron beam source directed perpendicular to the high explosive surface. The H.E. chosen in these calculations was TATB, a new shock insensitive explosive. Findings, however, are representative of what would be found in other high explosives had they been used. Two incident electron beam energies were chosen for this work - 50 MeV and 100 MeV. Both electron sources were considered to be mono-energetic as input to the Monte Carlo electron/photon transport code SANDYL.²

The SANDYL code allowed a 9x11 cylindrical grid of zones to be used for studying both the longitudinal energy deposition development as well as the radial deposition profiles. Although the radial distances from axis for both the 50 MeV and 100 MeV zoning were equal, the layer thicknesses along the Z axis associated with each energy were not equal. The thicknesses chosen were modeled to afford a well defined longitudinal energy breakdown as obtained from one-dimensional calculations in TATB from the ETRANMS³ computer code. Values for both the radii and Z distances for the zoning grid are given in Table I of this document. Figure 1 shows the actual grid of zones as generated from the values for 100 MeV found in Table I. Cylindrical ring zones are obtained by rotation about the axis of symmetry, the Z axis. Particles were transported throughout the grid until a cut-off energy of 1 keV was reached. At that time the particle was locally deposited. A pre-target zone that contained the electron source was composed of air and had a depth of 2 cm. All Z axis values found in Table I have already had this distance subtracted off.

Figure 2 contains the longitudinal energy deposition comparison for the 50 MeV and 100 MeV calculations for the on-axis radial zones. It can be seen that the 50 MeV calculation gives about a factor of two larger value energy deposition per kilojoule at its maximum point than does the 100 MeV calculation. However, the 100 MeV case is capable of deeper penetration into the high explosive than is obtainable at 50 MeV.

If consideration is to be given to initiation criteria within the high explosive, not only the evolved pressures obtained, but also the depth of beam penetration is important.

The radial energy deposition profiles for the first five layers of TATB at 50 MeV can be seen in Figure 3, while Figure 4 contains the radial energy profile calculations for the first five layers at 100 MeV.

Direct comparisons of each layer's radial deposition for the 50 MeV and 100 MeV calculations can be seen in Figure 5 through Figure 9. Associated conversion factors from MeV/g/electron to cal/g/kJ/cm² are shown at the bottom of Figure 5. All curves are statistically good to within 10%.

References

1. Bloom, G. H., Carson, J. K., Kruger, H. W., "Experimental Shock Initiation of High Explosives by Electron Beams" (U), UCID-16882, (1975).
2. Colbert, H. M., "SANDYL - A Computer Program for Calculating Combined Photon-Electron Transport in Complex Systems", Sandia Laboratory Report SLL-74-0012 (1974).
3. Kovar, F. R., "ETRANMS - A One-Dimensional Monte Carlo Electron/Photon Transport Code for Multimaterial Targets", UCRL-51493, (1973).

Radii Distances From Axis (cm)	Widths of Zones Along the Z Axis within the High Explosive (cm)
.20	<u>50 MeV</u>
	0-1.5 Layer 1
	1.5-3.4 Layer 2
.40	3.4-5.2 Layer 3
	5.2-7.3 Layer 4
	7.3-8.3 Layer 5
	8.3-9.4 Layer 6
.75	9.4-10.4 Layer 7
	10.4-11.5 Layer 8
1.50	11.5-12.5 Layer 9
	12.5-13.5 Layer 10
2.00	<u>100 MeV</u>
	0-2.5 Layer 1
2.50	2.5-7.5 Layer 2
	7.5-10.5 Layer 3
	10.5-13.0 Layer 4
3.00	13.0-15.5 Layer 5
	15.5-17.0 Layer 6
3.75	17.0-18.5 Layer 7
	18.5-20.5 Layer 8
5.00	20.5-22.75 Layer 9
	22.75-26.0 Layer 10
	26.0-29.0 Layer 11
	29.0-32.0 Layer 12

TABLE I - CONIC AND PLANE POSITIONS AS USED IN SANDYL

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FIGURE 2

LONGITUDINAL ENERGY
DEPOSITION
ON-AXIS IN TATB

FIGURE 3

RADIAL ENERGY DEPOSITION
IN TATB
FOR 50 MeV ELECTRONS

FIGURE 4

RADIAL ENERGY DEPOSITION
IN TATB
FOR 100 MeV ELECTRONS

FIGURE 5

RADIAL DEPOSITION PROFILE
LAYER 1

FIGURE 6

RADIAL DEPOSITION PROFILE
LAYER 2

⊙ 50 MeV ELECTRONS
x 100 MeV ELECTRONS

E+01

E+00

E-01

E-02

E-03

MeV/g/electron

Radius (cm)

5 CYCLES X TO 2015 JMS

SEMI-LOGARITHMIC

Buffalo New York

GRAPHIC CONTROLS COMPANY

Model 800 B A

GRAPH PAPER

RADIAL DEPOSITION PROFILE
LAYER 3

@ 50 MeV ELECTRONS
 X 100 MeV ELECTRONS

FIGURE 8

RADIAL DEPOSITION PROFILE
LAYER 4

⊙ 50 MeV ELECTRONS
x 100 MeV ELECTRONS

FIGURE 9

RADIAL DEPOSITION PROFILE
LAYER 5

⊙ 50 MeV ELECTRONS
x 100 MeV ELECTRONS

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