# Shock Initiation of Wedge-shaped Explosive Measured with Smear Camera and Photon Doppler Velocimetry

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## 1. INTRODUCTION

Triaminotrinitrobenzene(TATB) is an important insensitive high explosive in conventional weapons due to its safety and high energy. In order to have an insight into the shock initiation performance of a TATB-based insensitive high explosive (IHE), experimental measurements of the particle velocity histories of the TATB-based Explosive using Photon Doppler Velocimetry and shock wave profile of the TATB-based explosive using High Speed Rotating Mirror Smear Camera had been performed. In this paper, we would describe the shock initiation performance of the TATB-based explosive by run-to-detonation distance and the particle velocity history at an initialization shock of about 7.9GPa. The parameters of hugoniot of unreacted the TATB-based explosive and Pop relationship could be derived with the particle velocity history obtained in this paper

## 2. EXPERIMENTAL DETAILS

The experimental configuration for the shock initiation experiments of the TATB-based Explosive was shown in Figure 1 which included detonator, planar shock wave generator, ignitable explosive, main explosive, and wedge-shaped the TATB-based explosive. In this experiment, a plane shock wave was generated by planar shock wave generator and propagated into detonation wave gradually when spreading in the main explosive. A definable initialization shock wave was created to initiate the test the TATB-based Explosive through a tungsten alloy attenuator.

Smear Camera was used to record the space-time trace of shock or detonation wave with the air gap between the wedge-shaped the TATB-based Explosive and PMMA which would luminesce when the shock or detonation wave getting the interface of test explosive and PMMA.

In order to obtain the particle velocity profiles after shock wave or detonation wave, we measured the interaction of the shock/detonation front with a transparent window made of

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Lithium Fluoride (LIF). The interface of Lithium Fluoride window in contact with the TATB-based Explosive was coated with aluminum in order to reflect laser beam back into the interferometer. Lithium Fluoride was used for the window material because its shock impedance is between the the TATB-based Explosive unreacted Hugoniot and the TATB-based Explosive products isentrope, so there is minimal effect on the flow. The experimental setup for shock initiation performance measurements of the TATB-based Explosive was shown in Figure. 1. The experimental setup details are given in Table 1.

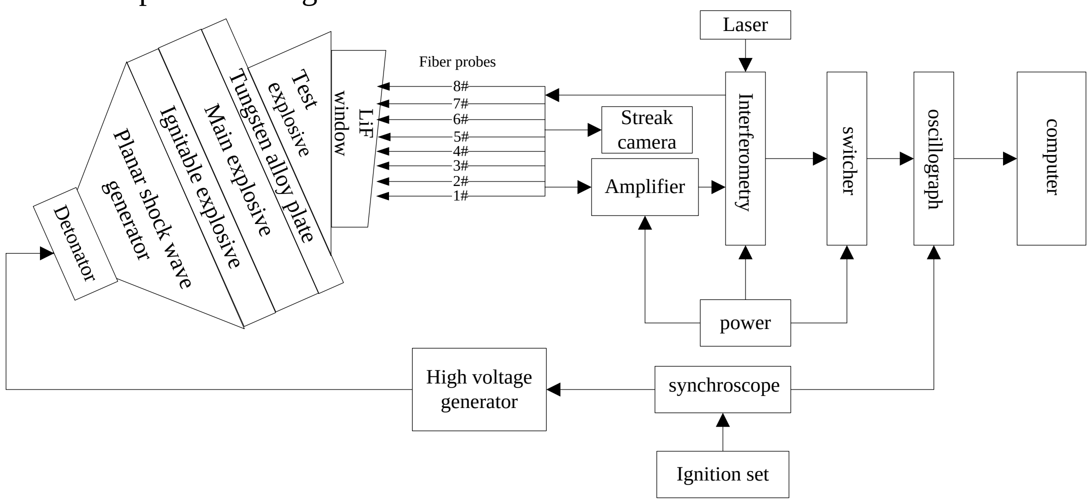


**Figure1. The sketch of Experimental setup and measurement system**

**Tab.1. The parameter of experiment setup**

| Initiation method | Confinement | Planar shock wave generator | Test explosive | LiF Window/coating | Diagnostics |
|---|---|---|---|---|---|
| 16# detonator | PMMA tube | Φ100×37° | the TATB-based Explosive Φ70×30° | 10 mm thick with 1.0 μm A1 | 8 beam to 1 PDV |

## 3. RESULTS AND DISCUSSION

The space-time trace of shock or detonation wave obtained by Smear Camera was shown in Figure. 2. It was easy to distinguish the shock wave trace which was narrow enough because of the air gap between the TATB-based Explosive and PMMA window was thick and constrictive and release wave behind the initial shock wave when initial shock got the test explosive. Space-time trace in this segment is on a slight slope for the velocity of shock wave accelerating. The space-time trace became wider for production of the TATB-based explosive luminescing continually after the point of the transition to detonation and the velocity of detonation wave was fixed. The duration time of shock to detonation transition is 1.50μsec and the duration length of shock to detonation transition was 8.31mm. Smear Camera result showed that, at an initial shock of about 7.9GPa, the the TATB-based explosive could detonated unfailingly. The average velocity of shock wave was 5267m/s and the velocity of detonation wave was 8013 m/s.

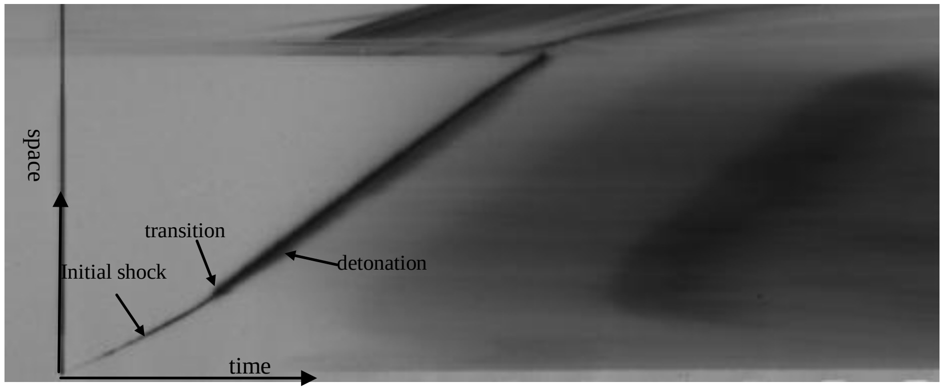


**Figure2. High speed rotating mirror steak camera record and its interpretation**

Fig.3 showed the result of the velocity histories of particles after shock or detonation measured by Photon Doppler Velocimetry. The 1#~5# fiber probes in the figure showed that the the TATB-based Explosive did not detonate within 8 mm and the velocity of particles after shock wave were increasing for the test J the TATB-based Explosive decomposed and discharged more and more energy before the transition to detonation. The test explosive detonated between the 5# and 6# fiber probes.

Particle velocity histories of the TATB-based Explosive after detonation shown in Figure 3. agreed well with the ZND model which including shock front without chemical reaction, i.e. Von Neumann spike, and later chemical reaction zone and the sonic locus/CJ point where most chemical reactions occured.

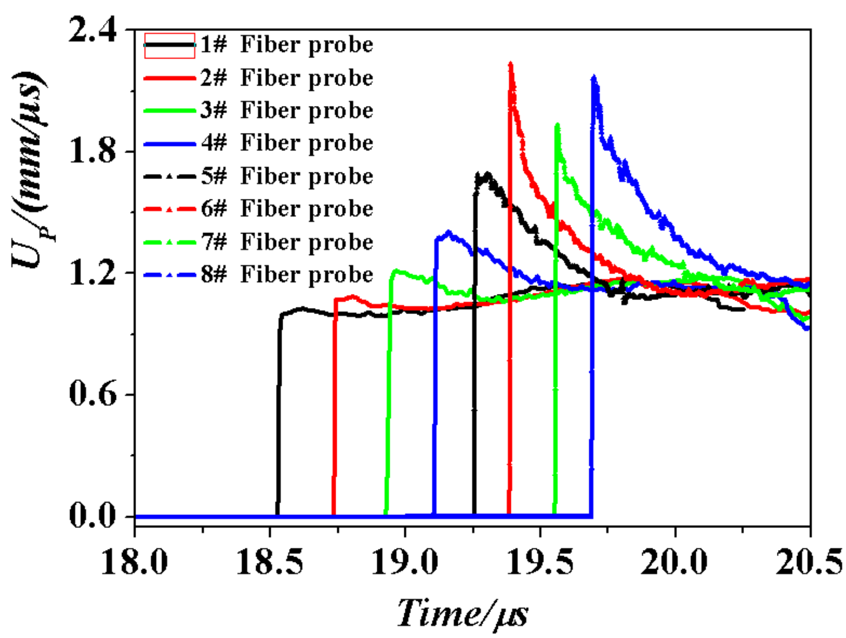


**Figure3. Particle velocity profiles at the TATB-based Explosive /LIF interface obtained by Photon Doppler Velocimetry**

Because this shock wave experiment required a LiF window to maintain the stress and reflection during the experiment, then particle velocity measured by PDV diagnostics was the apparent velocity, not the true velocity when the laser beam transmitted through a LiF window. It was necessary to determine LiF window correction so that the true velocity could be calculated from the measured apparent particle velocity. Ulterior correction should be adopted to obtain the particle velocity histories of the TATB-based Explosive after detonation for the shock impedances mismatch of LiF window and the TATB-based Explosive. Corrections factors of LiF window were given by Jensen and hugoniot factor of LiF window were given by Carter. Particle velocity histories after the two-steps correction was shown in Figure.4.

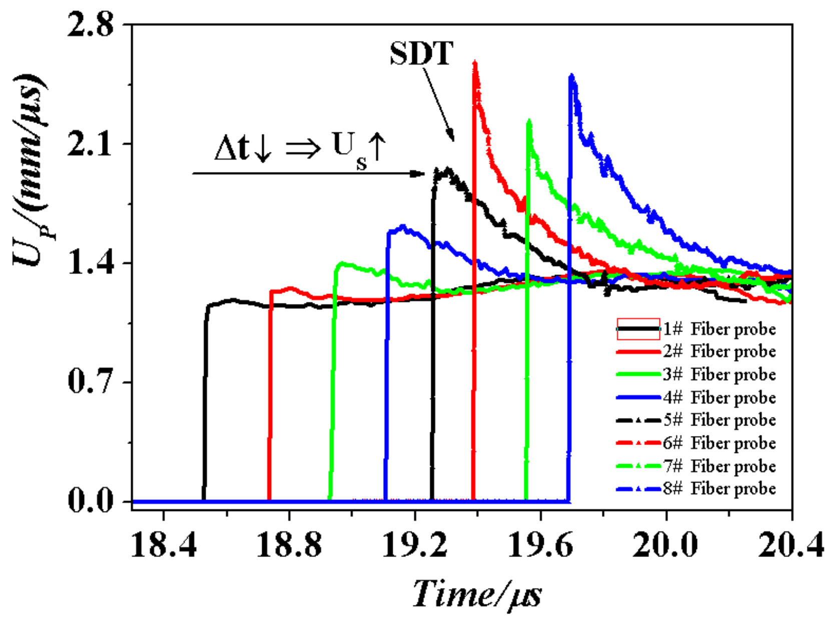


**Figure4. Particle velocity profiles of JBO9021**

The velocity of particles in the 6# fiber probe jumped abruptly, which mean that the test the TATB-based Explosive could detonated unfailingly and the duration length of shock to detonation transition was 8~9mm at an initial shock of about 7.9GPa. The particle velocity of the TATB-based Explosive after detonation was 2200~2700 m/s.