SHOCK INITIATION OF DETONATION IN HETEROGENEOUS EXPLOSIVES BASED ON NITROMETHANE

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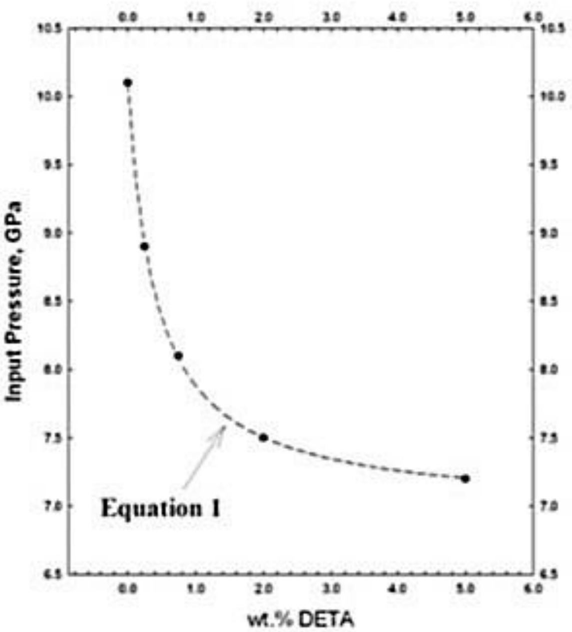
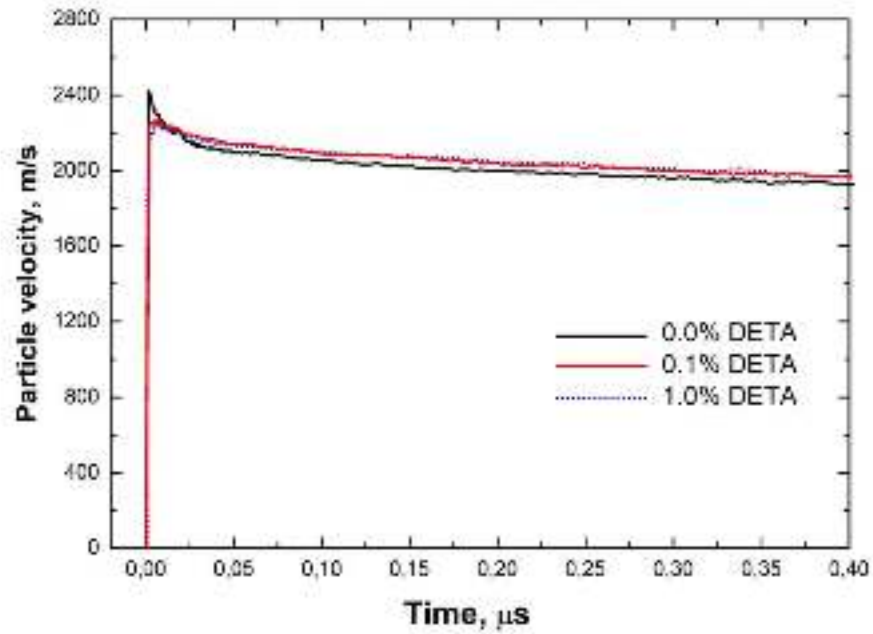
Effect of amines on the shock sensitivity of nitromethane



The effect of DETA on the detonation initiation pressure in nitromethane.

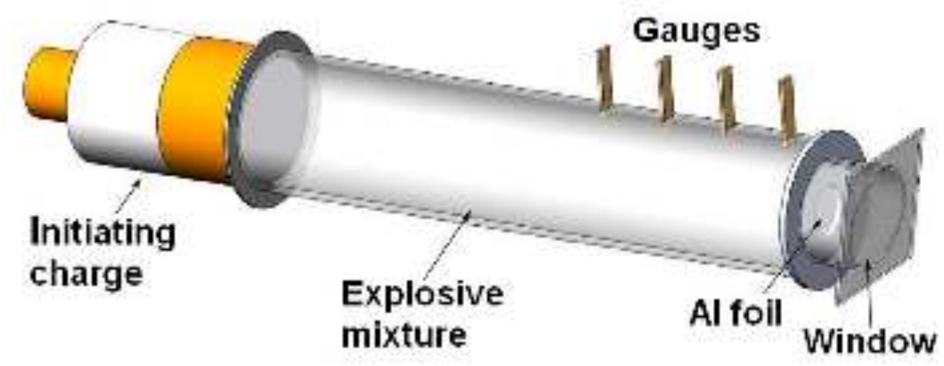


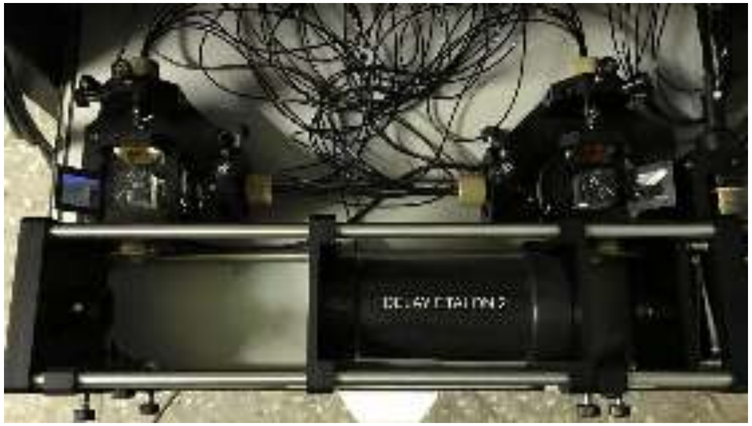
Particle velocity profiles of NM/DETA interface with water at DETA concentration of 0, 0.1 and 1%.

Stephen A. Sheffield, Dana M. Dattelbaum, Ray Engelke, Robert R. Alcon, Blandine Crouzetƒ, David L. Robbins, David B. Stahl, and Richard L. Gustavsen / **Homogeneous shock initiation process in neat and chemically sensitized nitromethane.**
13-th Int. Det. Symp., Norfolk, USA, pp. 401-407, 2006.

Utkin A. V., Mochalova V. M., Logvinenko A. A. (2013). Effect of diethylenetriamine on the structure of detonation waves in nitromethane. *Combustion, Explosion, and Shock Waves*, *49*(4), 478-483.

Experimental scheme





A VISAR laser interferometer

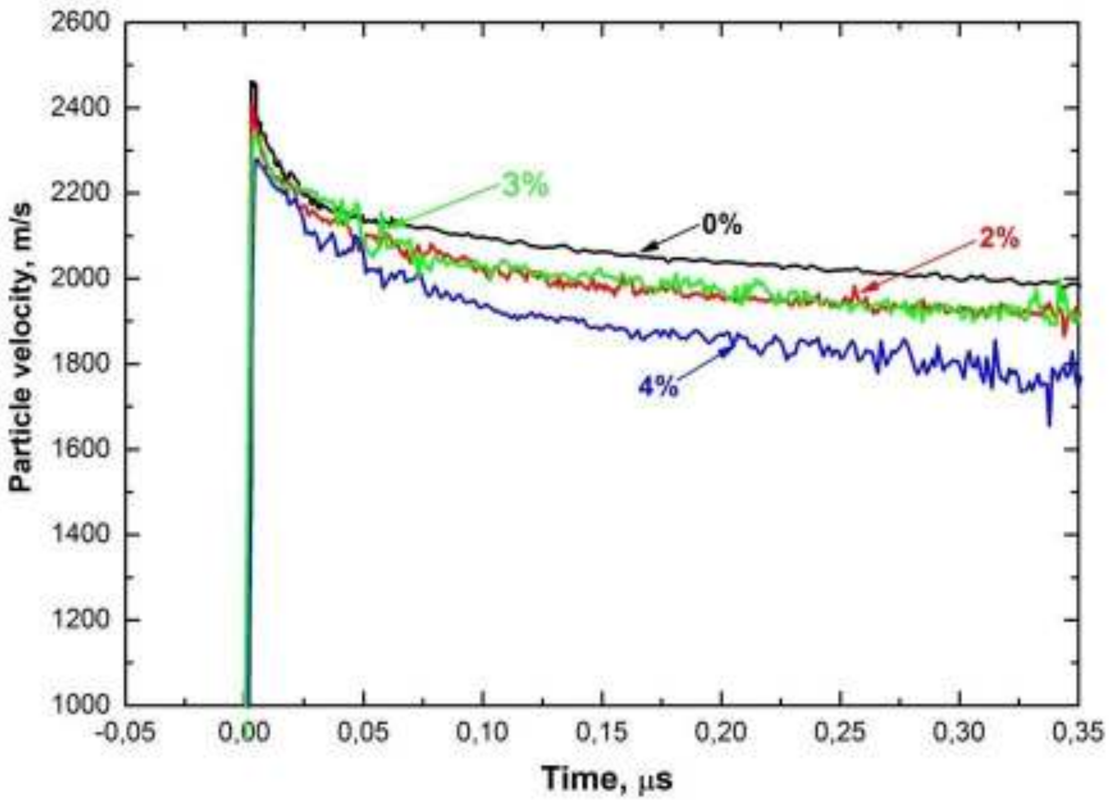
The initiating charge: **pressed RDX;**

Al foil **400 μm thick;**

The studied explosive mixture **was placed in a glass confinement with a length of 10 to 20 diameters;**

4 gauges **for measuring the detonation velocity.**

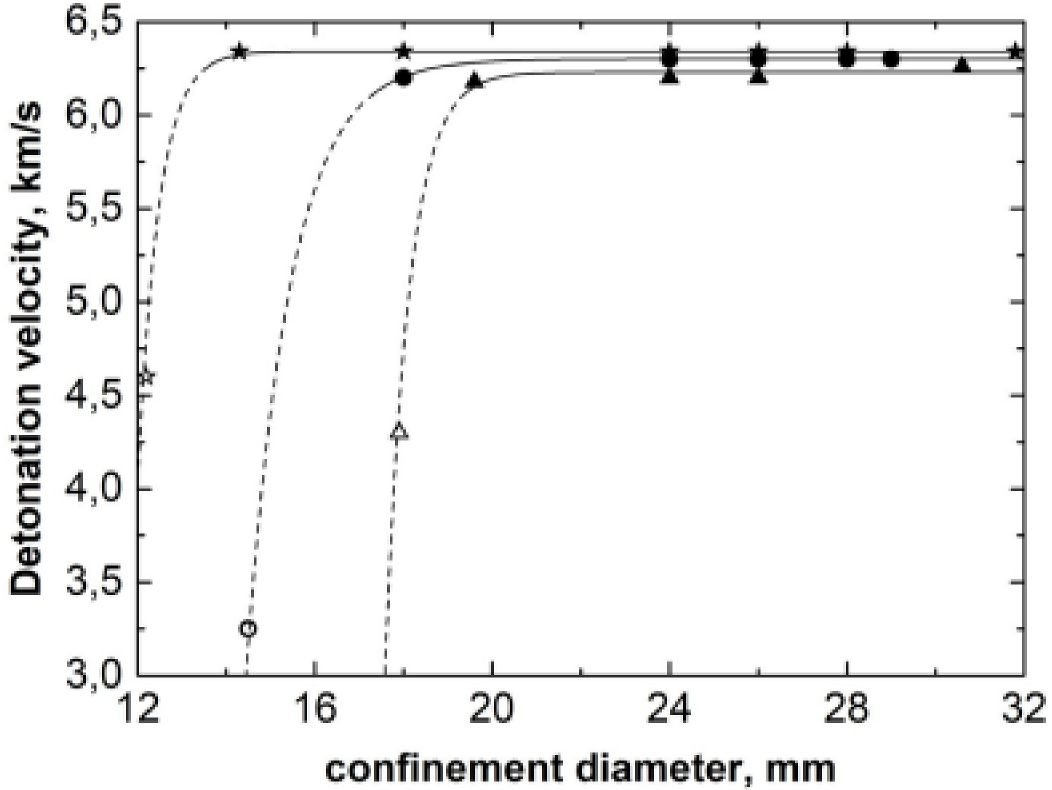
Nitromethane/PMMA



№	% PMMA	D, km/s
1	0	6,34
2	2	6,30
3	3	6,30
4	4	6,21

Particle velocity profiles for the mixture of NM/PMMA at different concentrations of PMMA: 0, 2, 3, 4%.

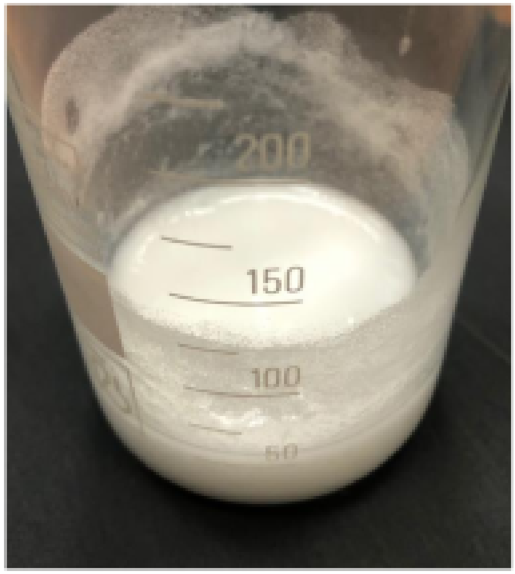
Nitromethane/PMMA



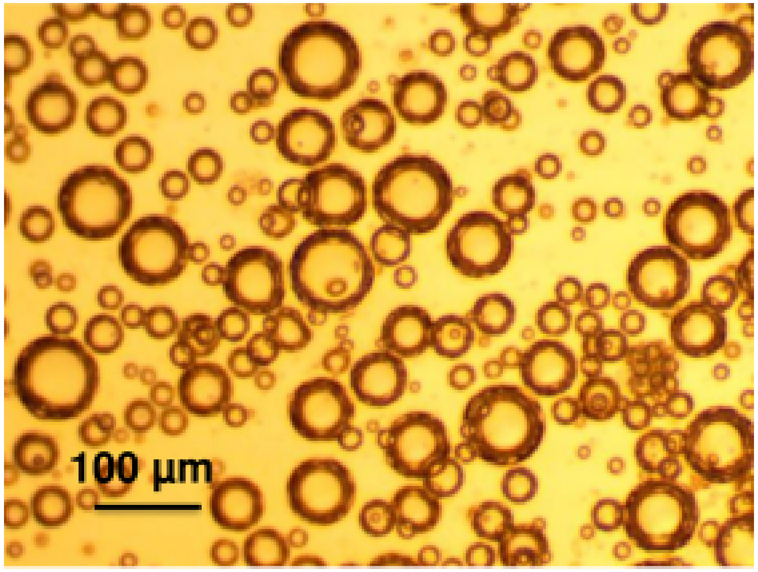
№	% PMMA	d, mm
1	0	13.5
2	3	16.5
3	4	18.5

Dependence of the detonation velocity of the NM/PMMA mixture on the diameter of glass confinement at a concentration of PMMA: ☆ – 0%, ○ - 3%, Δ - 4%.

Nitromethane/PMMA/GMB

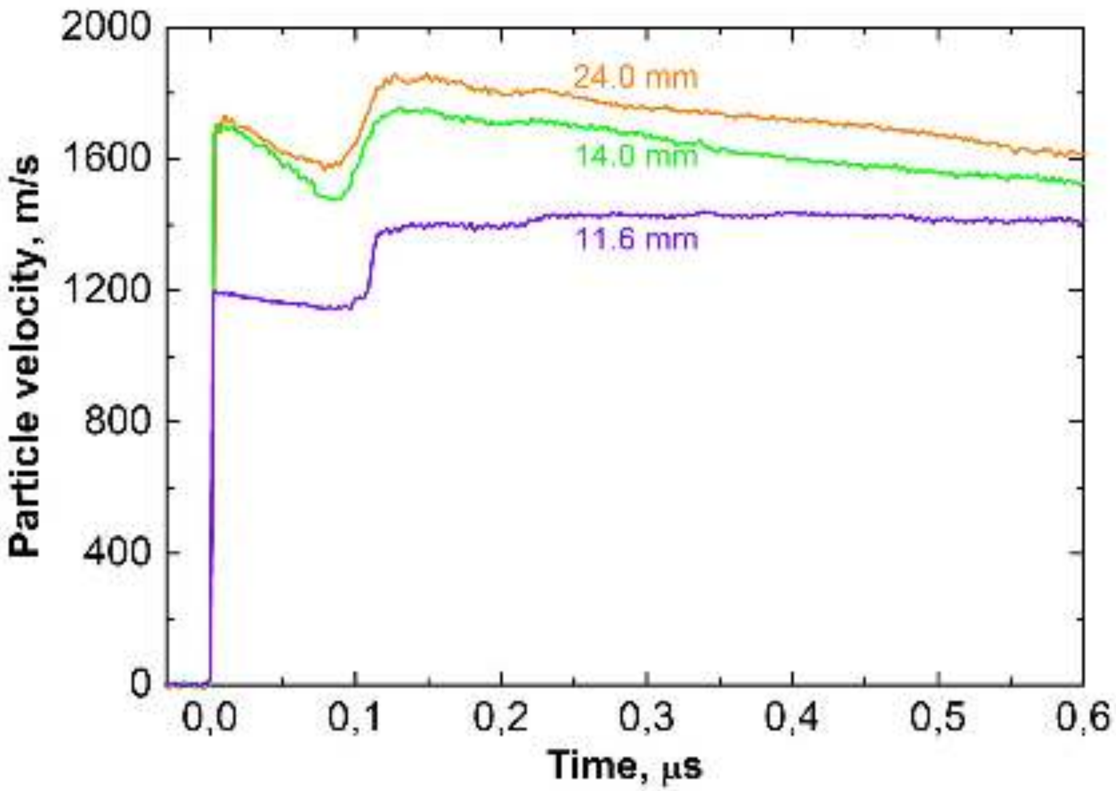


The prepared mixture of (NM/PMMA)/microballoons (97/3/)2



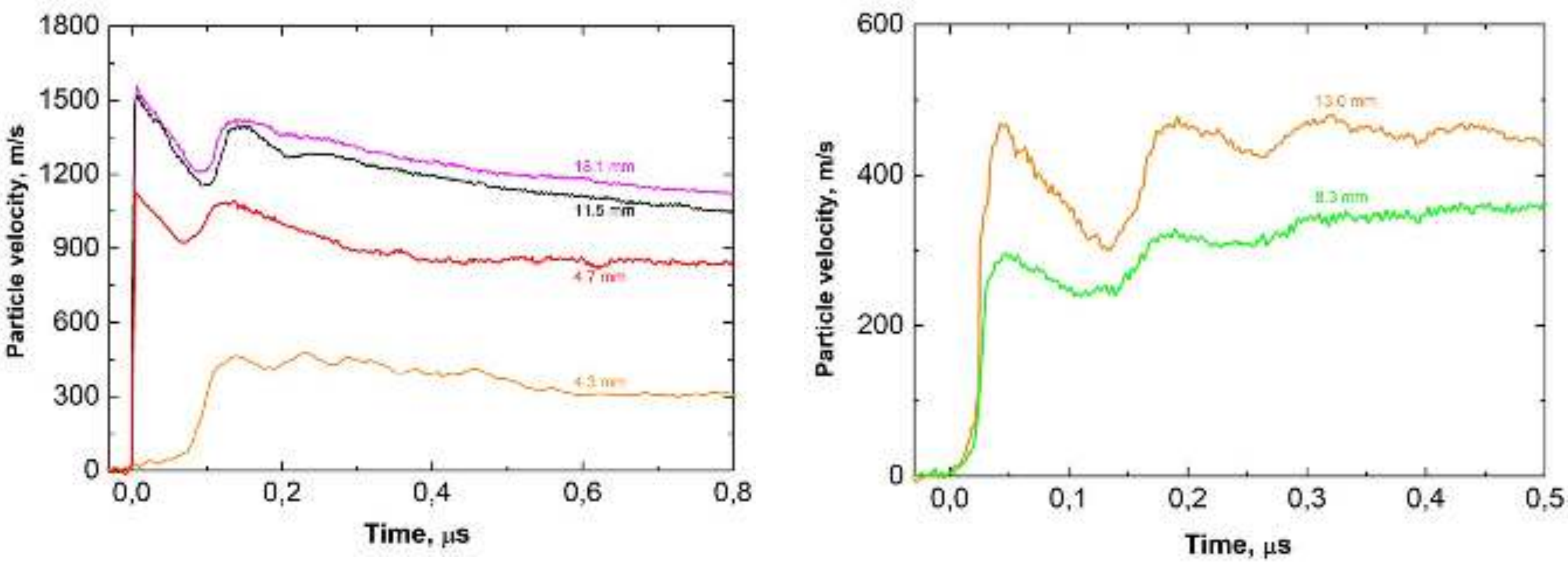
Microphoto of the mixture of (NM/PMMA)/microballoons (97/3/)2

Nitromethane/PMMA/GMB



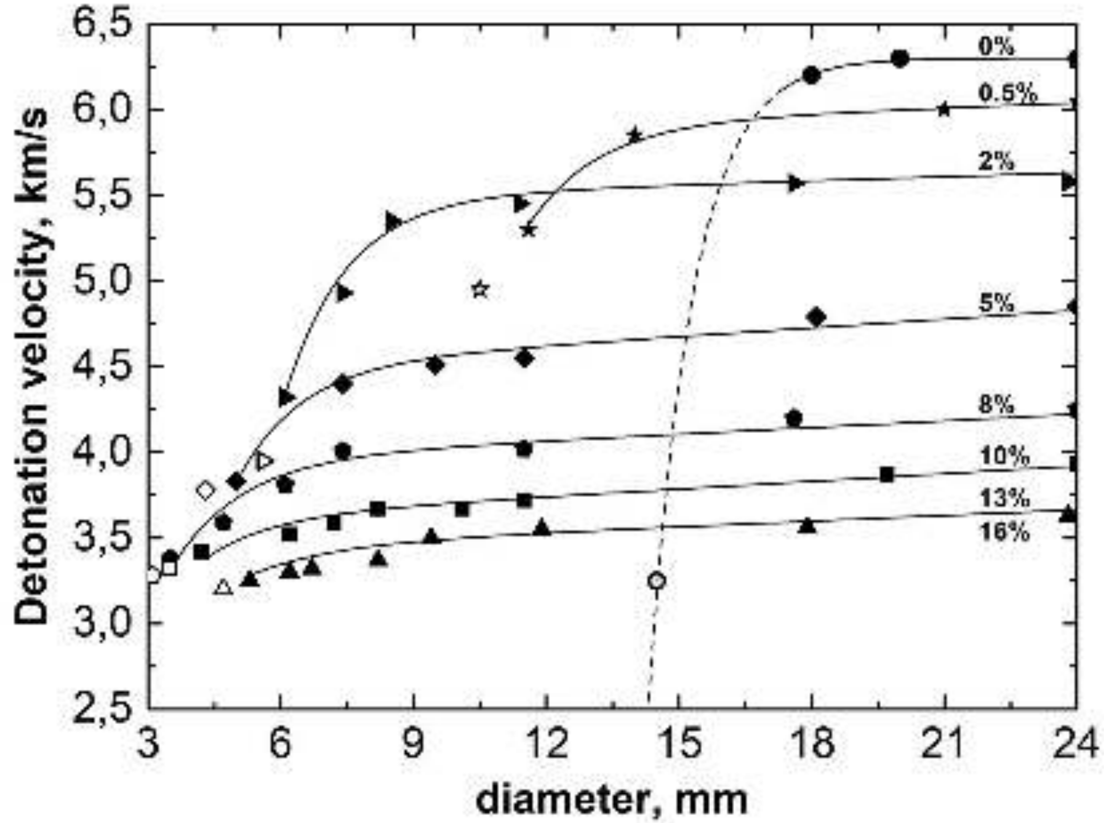
Particle velocity profiles for the mixture of (NM/PMMA)/microballoons (97/3)/0.5 at different values of the inner diameter of the glass confinement.

Nitromethane/PMMA/GMB



Particle velocity profiles for the mixture of (NM/PMMA)/GMB at a concentration of microballoons of 5% and 24%. The figures show the values of the inner diameter of the glass confinement.

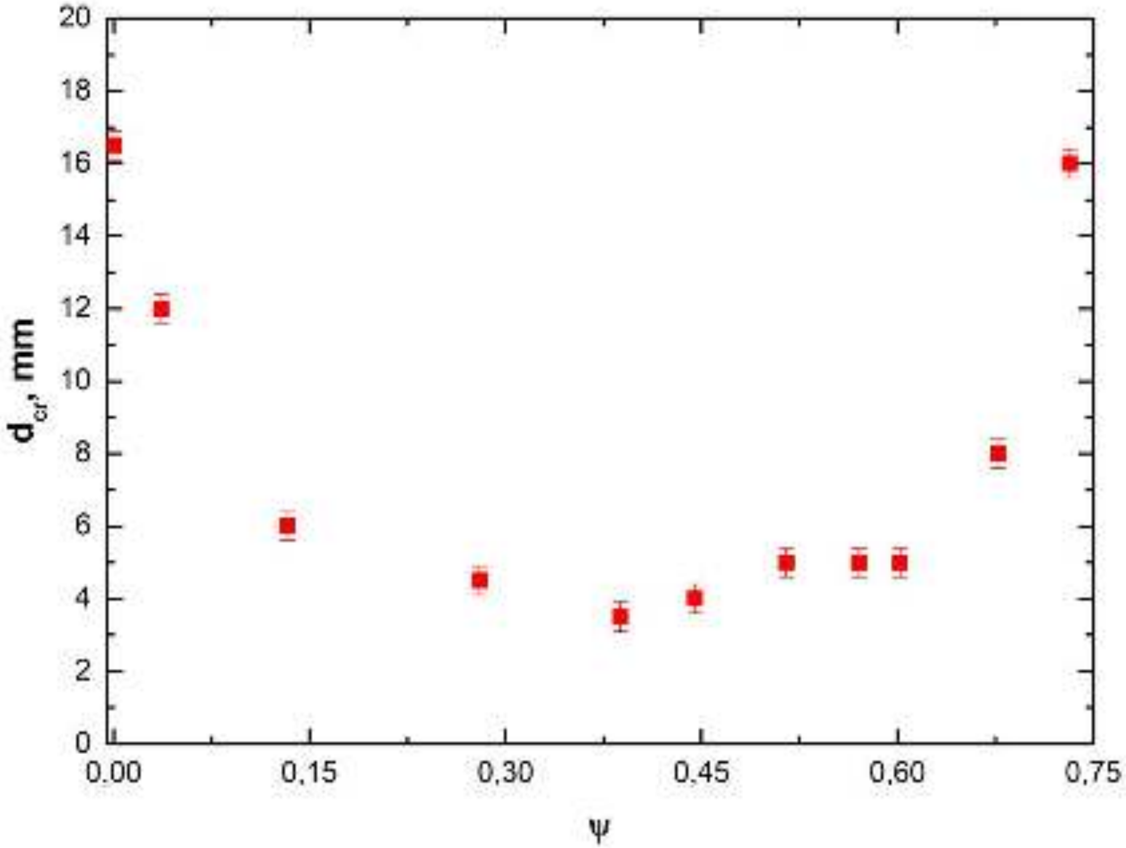
Nitromethane/PMMA/GMB



GMB [%]	ρ_0 [g/cm^3]	d_{cr} [mm]	D_{id} [km/s]
0	1.120	16.5	6.30
0.5	1.082	12.0	6.20
2	0.982	6.0	5.70
5	0.830	4.5	4.98
8	0.718	3.5	4.40
10	0.659	4.0	4.00
13	0.586	5.0	3.67
16	0.528	5.0	3.67
18	0.496	5.0	3.90
24	0.418	8.0	2.60
30	0.361	16.0	2.60

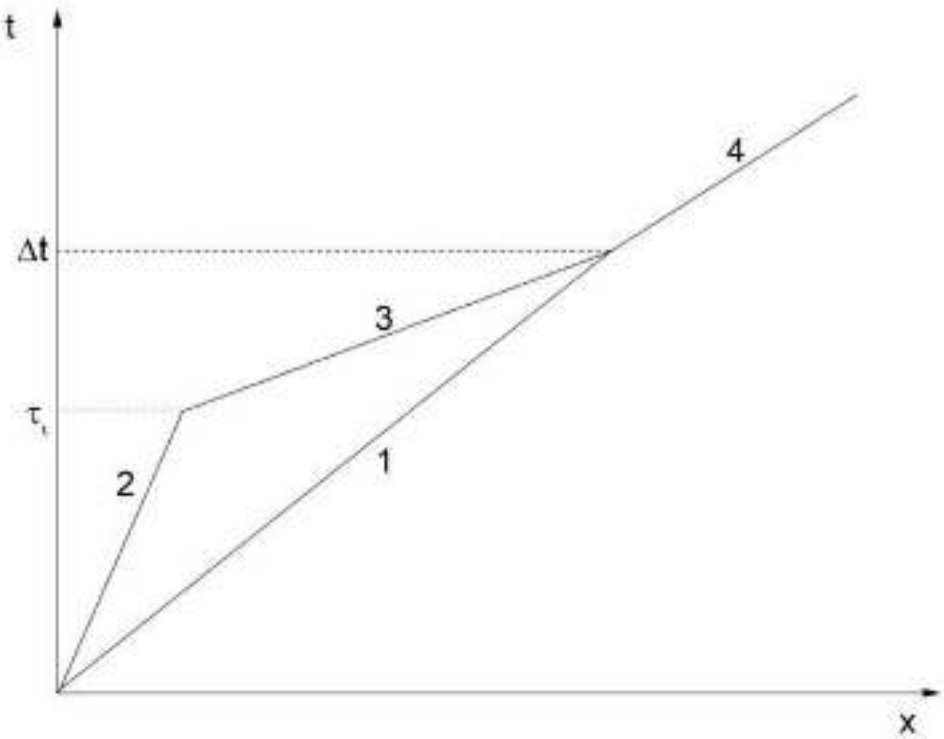
The dependence of the detonation velocity of the mixture of (NM/PMMA)/GMB on the diameter of the glass confinement at different concentrations of microballoons, which are indicated in the figure by numbers in wt.%.

Nitromethane/PMMA/GMB



Dependence of the critical diameter of the mixture of (NM/PMMA)/GMB in a glass confinement on the porosity.

Initiation of detonation

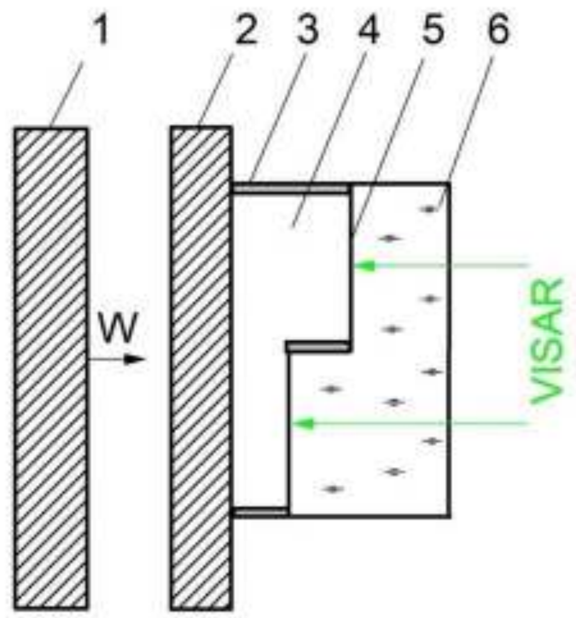


1 – Initial shock;
2 – Interface of baseplate/explosive;
3 – Superdetonation;
4 – Detonation;
τ_i – induction time.

Chaiken, R. F. (1960). Comments on hypervelocity wave phenomena in condensed explosives. *The Journal of Chemical Physics*, *33*(3), 760-761.

Campbell, A. W., Davis, W. C., & Travis, J. R. (1961). Shock initiation of detonation in liquid explosives. *The Physics of Fluids*, *4*(4), 498-510.

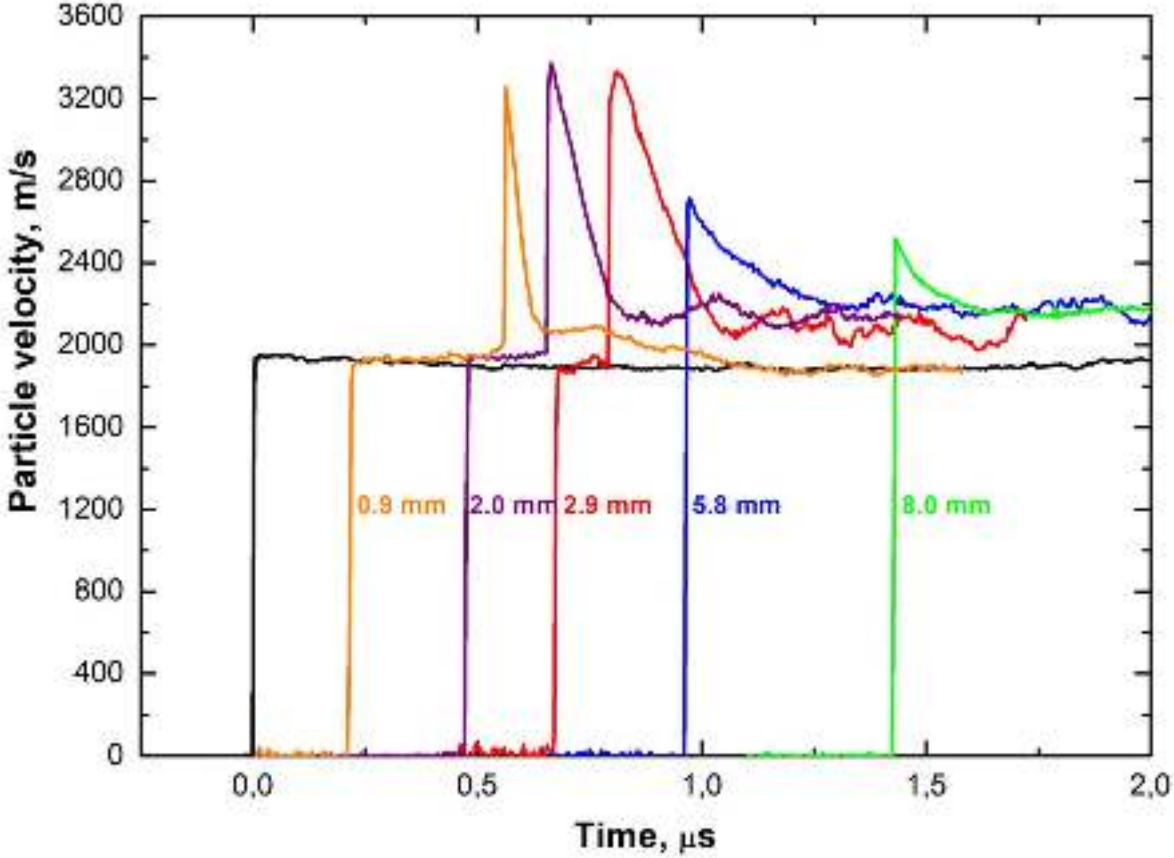
Initiation of the mixture



Scheme of the experiment.
1 – projectile;
2 – baseplate;
3 – confinement;
4 – explosive mixture;
5 – Al foil;
6 – water window.

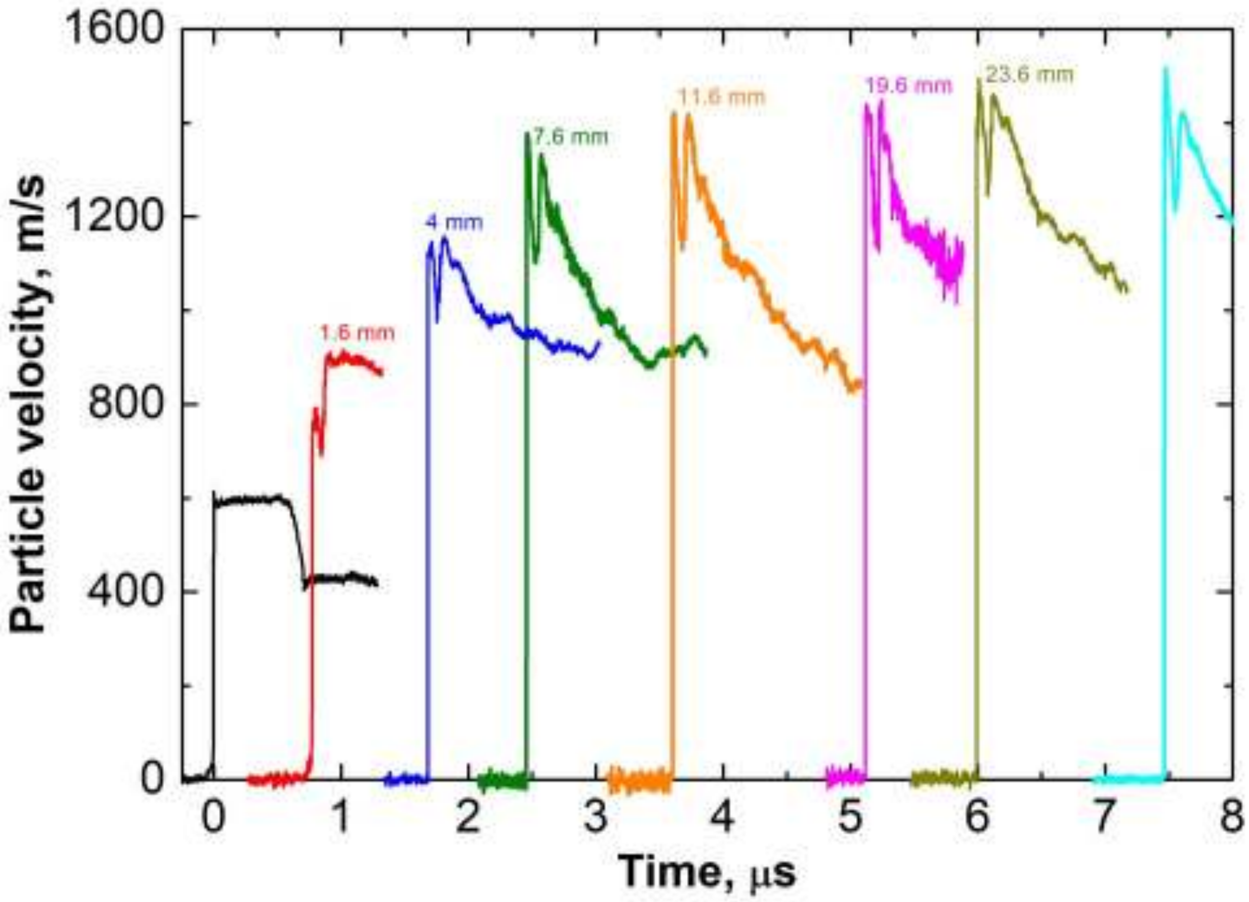
Photo of the experimental setup.

Initiation nitromethane



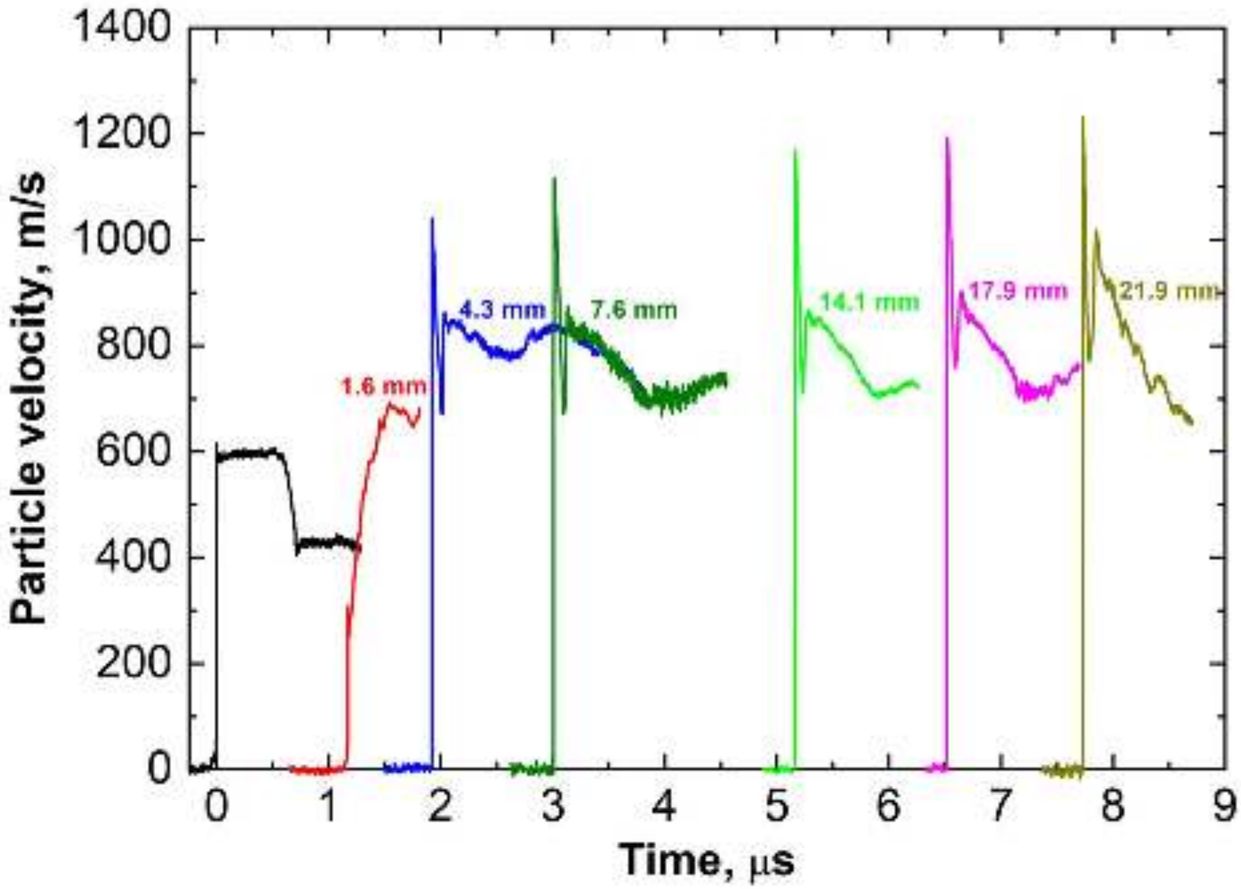
Particle velocity profiles for nitromethane. Projectile velocity is 2.5 km/s. Input to the mixture of 10 GPa is presented. The numbers indicate the distance from the Al baseplate.

Initiation of the mixture



Particle velocity profiles for the mixture of (NM/PMMA)/GMB (97/3)/5. Projectile velocity is 1.13 km/s. Input to the mixture of 1.1 GPa is presented. The numbers indicate the distance from the copper baseplate.

Initiation of the mixture



Particle velocity profiles for the mixture of (NM/PMMA)/GMB (97/3)/8. Projectile velocity is 1.13 km/s. Input to the mixture of 0.7 GPa is presented. The numbers indicate the distance from the copper baseplate.

SUMMARY

•A study of the reaction zone structure in steady detonation waves in gelled nitromethane and at GMB concentration of 0.5-30 wt.% was performed. It was shown that GMB additives do not qualitatively change the structure of particle velocity profiles.

•The critical diameter of the mixture decreases significantly at small GMB concentrations and reaches a minimum value of 3.5 mm at 8 wt.%, which is about 5 times lower than that in gelled NM.

•It is shown that the shock initiation of NM corresponds to the classical model of detonation development for homogeneous explosives.

•The addition of GMB to NM fundamentally changes the nature of detonation development under shock-wave action. The resulting profiles are similar to those observed in pressed explosives.