Qualification of Energetic Materials

TNO developed heat flow calorimetry

Energetic materials need to be assessed as safe and suitable for use in a specific application. The aim of qualification is to ensure that energetic materials are sufficiently characterised in order to be considered for an intended role as primary, booster or high explosive, solid gun, solid rocket or liquid propellant, or pyrotechnic composition.

The qualification process

Within NATO the principles and methodology for the qualification are given in STANAG 4170. AOP-7 is its guidance document and includes data requirements and (national) test procedures. For the Dutch MoD the lead document for type classification and qualification is MP 40-22.

The properties of the explosive should be identified by TNO Defence, Security and Safety, either by assessing the data provided by the manufacturer or by performing an (additional) experimental test program. This results in a qualification report and draft specifications for the explosive substance. Qualification programs are carried out as well directly for producers of energetic materials.

STANAG 4170: Principles and methodology for the qualification of explosive materials for military use.
AOP-7: Manual of data requirements and tests for the qualification of explosive materials for military use.
MP 40-22: Dutch Department Publication 40-22, Instruction regarding the type classification of munitions and the qualification of explosive substances.

Experimental capabilities and methods

TNO has a variety of facilities to perform the experimental qualification of energetic materials, contributes actively to the update and maintenance of NATO standards through participation in AC/326 SG1, and develops new or improves equipment and methods.

Chemical, physical and mechanical properties

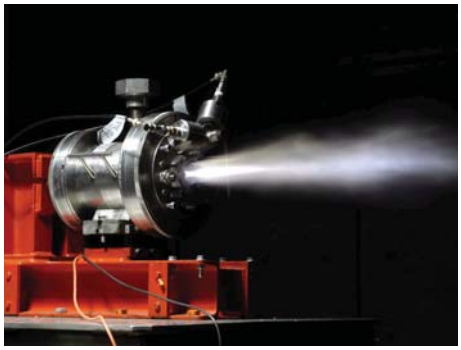
- Stability and thermal characterization with DSC, TGA, stabilizer depletion, heat flow calorimetry
- Ageing with climate chamber
- Compatibility
- Density
- Melting point, glass transition point using thermal or mechanical techniques
- Mechanical Characterization with DMA, TMA, compression tests and uniaxial testing.

Hazard properties

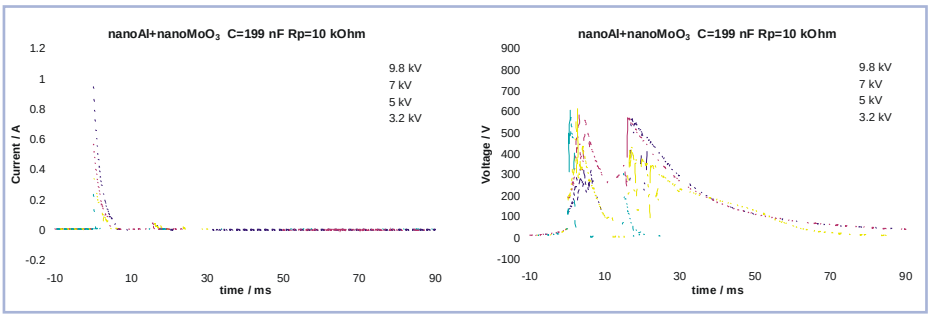
- Ignition temperature with DSC, TGA, Slow Cookoff Bomb
- Explosive response when ignited with slow and fast cookoff test, DDT tube, Koenen test
- Electrostatic discharge or spark sensitivity according to GBR or CZE method
- Impact sensitivity with BAM apparatus
- Friction sensitivity with BAM apparatus
- Shock sensitivity with water gap test, TNO PMMA gap test, flyer impact, fragment impact

Performance assessment

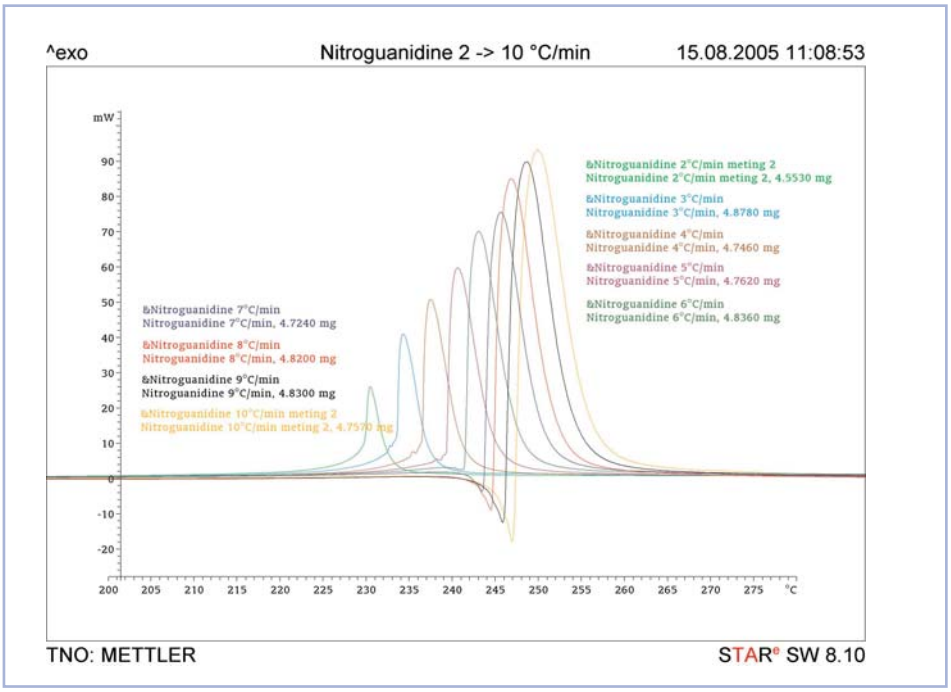
- Detonation velocity with resistance wire or fibre optic probe
- Critical diameter
- Vivacity with a range of closed vessels with maximum operating pressures ranging from 20 MPa to 1000 MPA
- Burn rate with strand burner, subscale motors



Propellant burn rate determination



imposed current and measured voltage in spark test



melting and decomposition as measured with DSC

TNO Defence, Security and Safety

TNO Defence, Security and Safety provides innovative contributions to the advance of comprehensive security and is a strategic partner of the Dutch Ministry of Defence to build up the defence knowledge-base. We employ our acquired knowledge for and together with contractors.

H.L.J. (Huub) Keizers, MSc.
huub.keizers@tno.nl

Lange Kleiweg 137
P.O. Box 45
2280 AA Rijswijk
The Netherlands

P +31 15 284 33 78
F +31 15 284 39 58
info-DenV@tno.nl
www.tno.nl