Temperature Independent Gun Propellants Based On NC And DNDA For IM Ammunition

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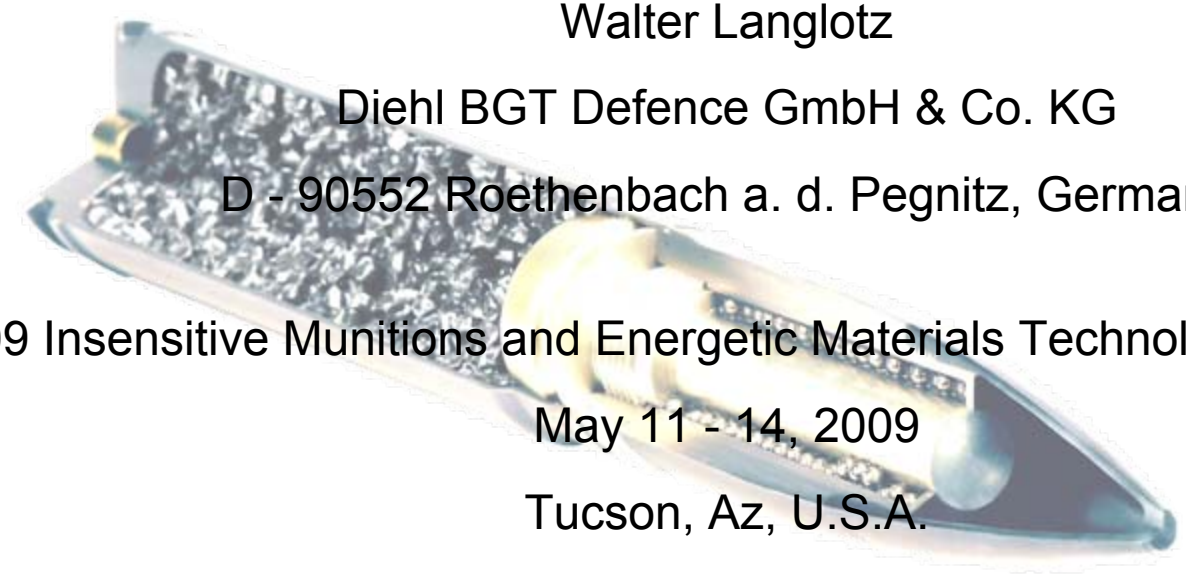

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Content

- Introduction
- Processing Technology
- Low Temperature Coefficient (LTC) Propellants
  - Temperature Behaviour, Closed Vessel Results
  - Characteristics of the Propellant Components
- Propellant Performance, Safety & Sensitivity Data
  - Long - Term Storage Stability
  - Influence of the Crystalline Components
  - IM Characteristic of the Propellant
  - Shaped Charge Tests
  - Erosivity
- Gun Firing in different Calibers
- PELE Cartridge
- Results & Conclusion

Introduction

Since approx. 100 years are known the Nitrocellulose Propellants

Self - Ignition Temperature ~ 175 °C

Also the Multi Base Propellants like SCDB and EI, ECL Propellants are

giving the Self - Ignition at ~ 175 °C

Nitrocellulose Propellants based on DNDA and RDX the
LTC Propellants are showing

- First Generation

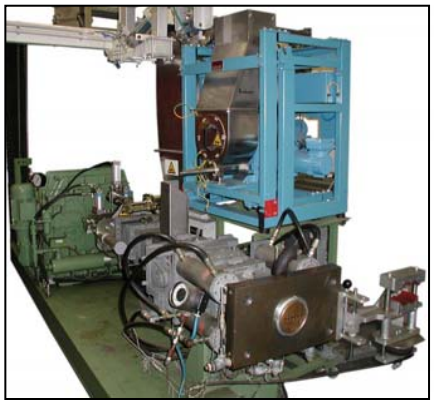
  Self - Ignition Temperature 200 - 210 °C

- Second Generation

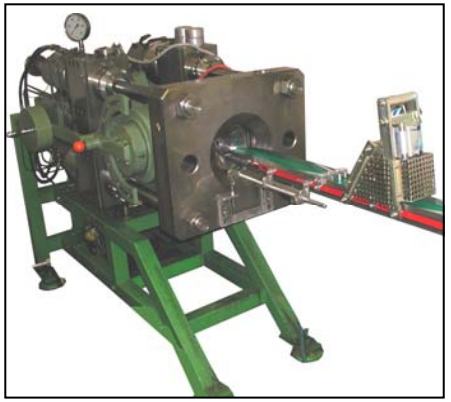
  Self - Ignition Temperature > 220 °C (Eurofighter Propellant etc.)

Processing Technology for Insensitive Gun Propellants based on DNDA

Continuous Process
- Shear Roll Mill
- Twin Screw Extruder (TSE) ZSK 58E



Batch Process
- Kneader / Mixer
- Rampress



Shear Roll Mill (Continuous Process)

DNDA Gun Propellants

- RDX (or FOX-7, FOX-12)
- Binder, Nitrocellulose
- DNDA Plasticizer

✳ Plasticizer mixed into the Propellant - Dough

NO SURFACE COATING

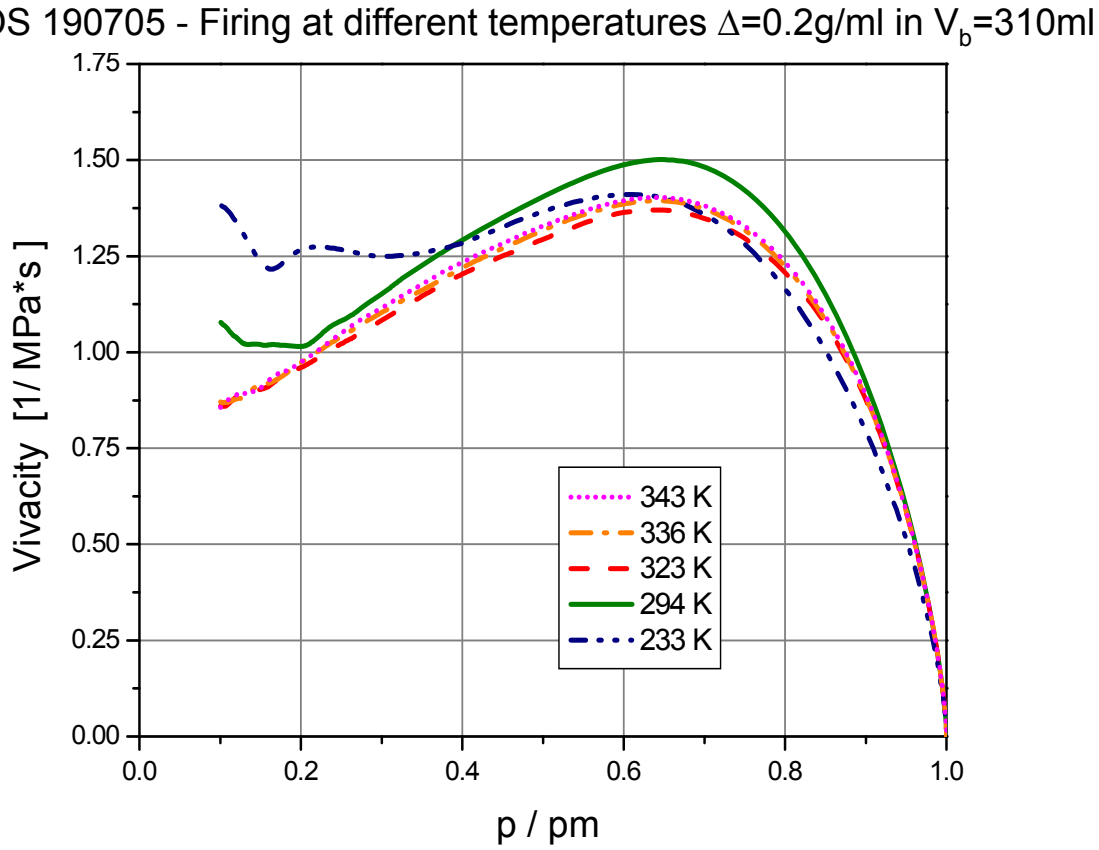
- energy density adaptable
- flame temperature approx. 500 K lower compared to NC Propellants

Formulation	*Impetus (J/g)*	*Flame Temp (K)*	*$\overline{M}w$ (g/mole)*
A	***1080***	***2540***	***19.4***
B	***1180***	***2910***	***20.8***
C	***1300***	***3390***	***21.6***

Closed Vessel Behaviour of LTC Propellants

Vivacity of Gun Propellant based on DNDA

Range -40 °C till +70 °C



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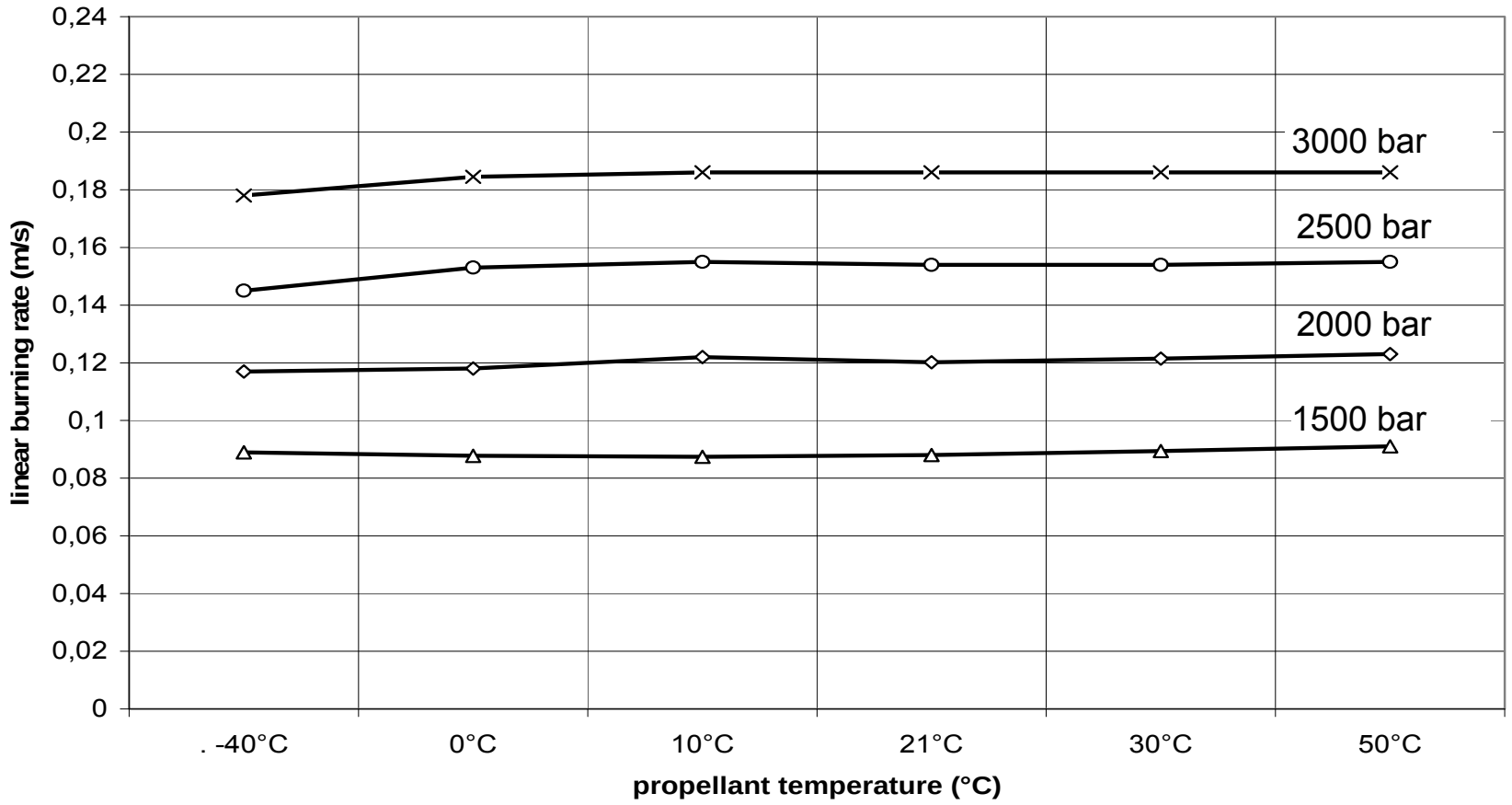
Linear burning rate of LTC Propellants at different pressures



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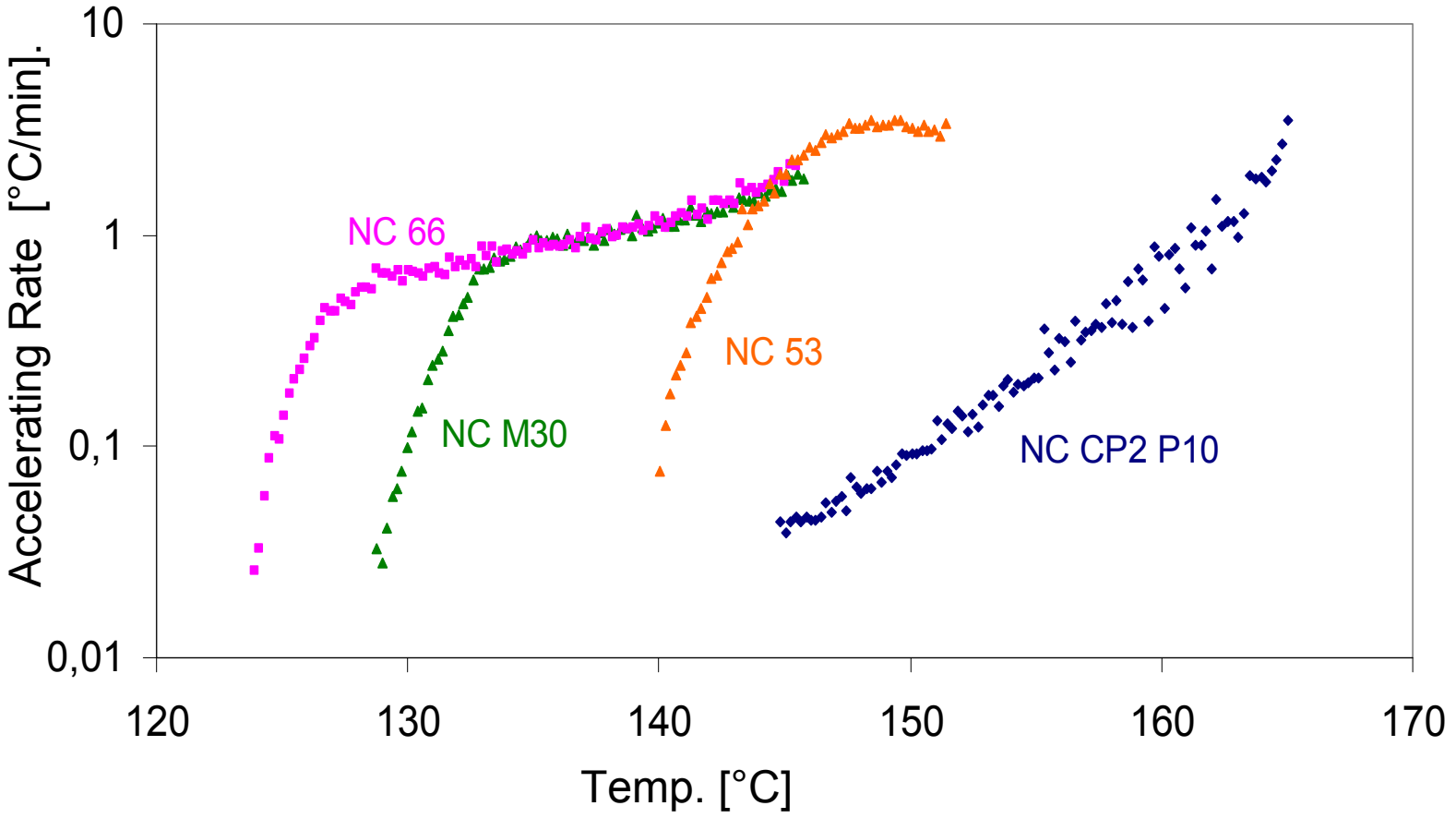
ARC Measurement of several Nitrocellulose (NC) Types



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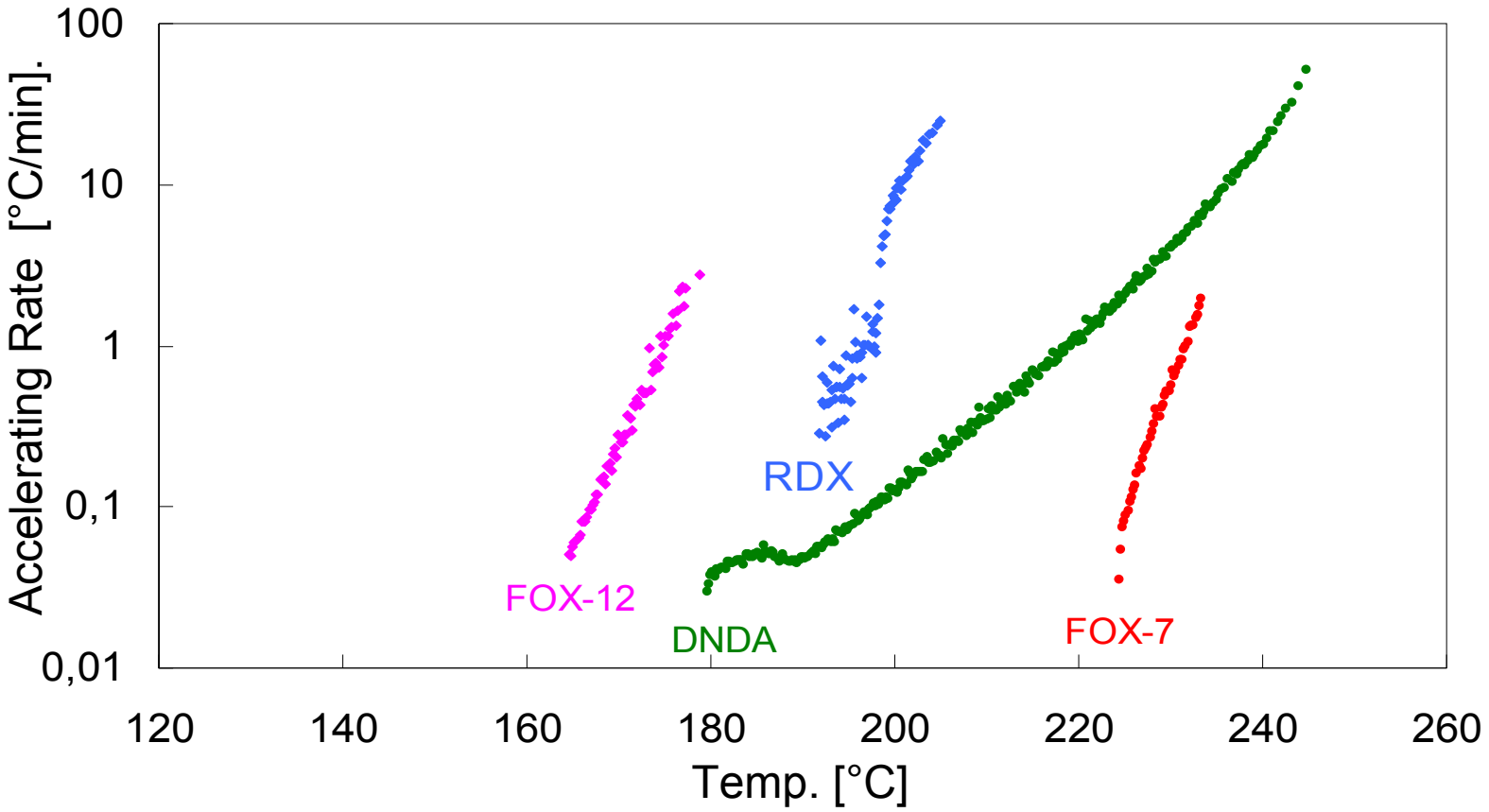
ARC Measurements of RDX, FOX-12 and DNDA



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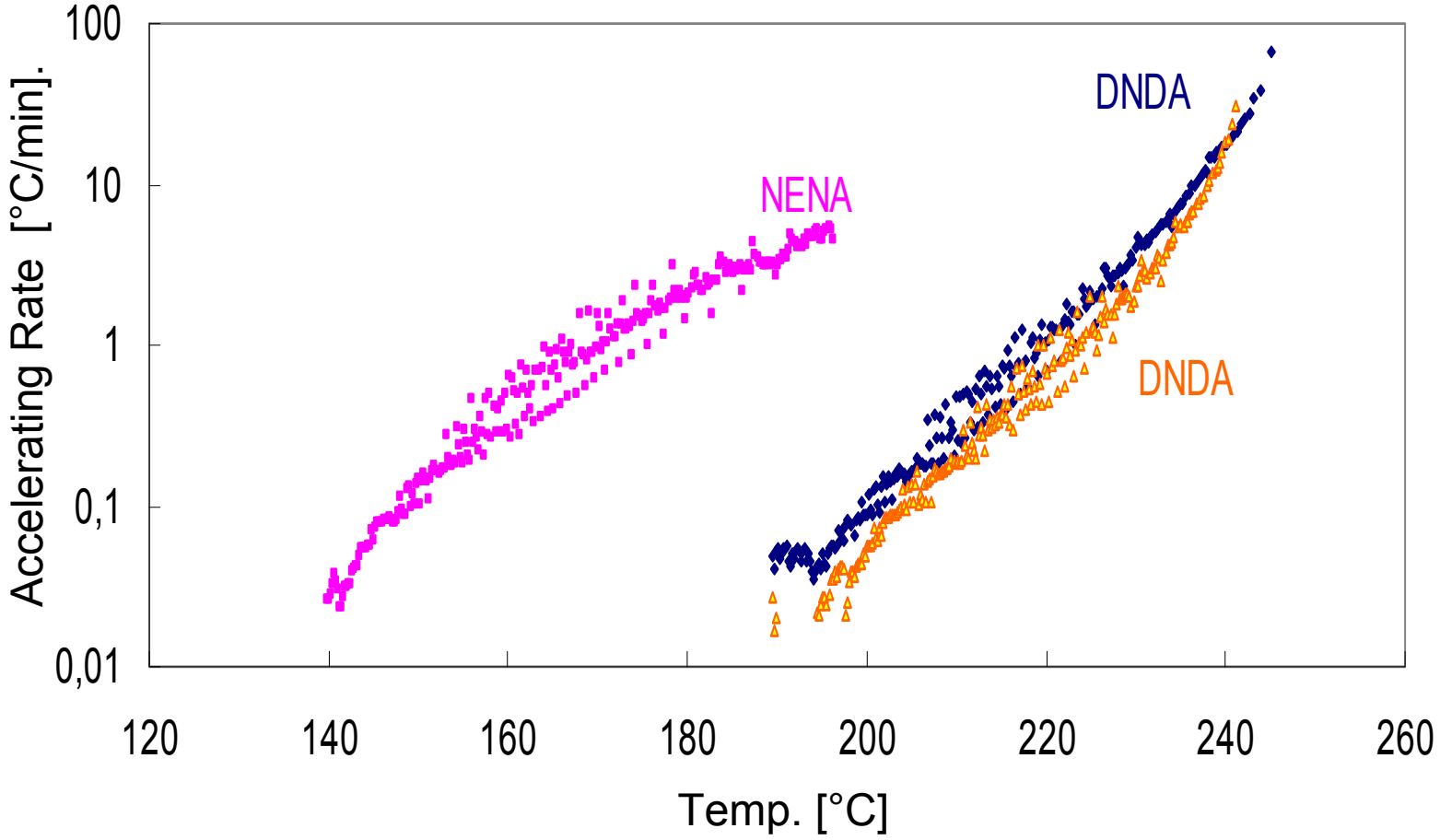
ARC
DNDA-5,7 compared with NENA



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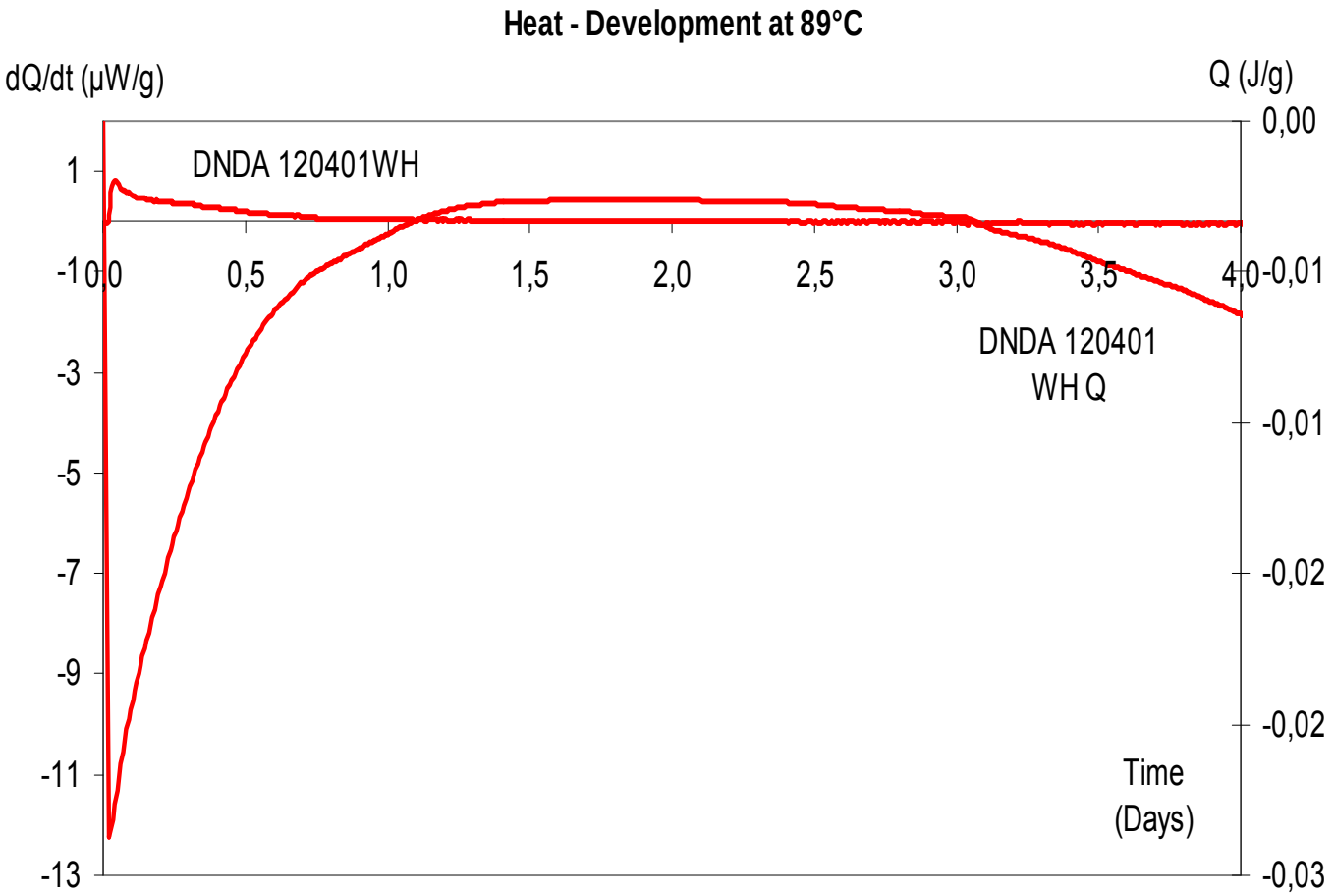
Microcalorimeter Result of DNDA-5,7 Endothermic Behaviour



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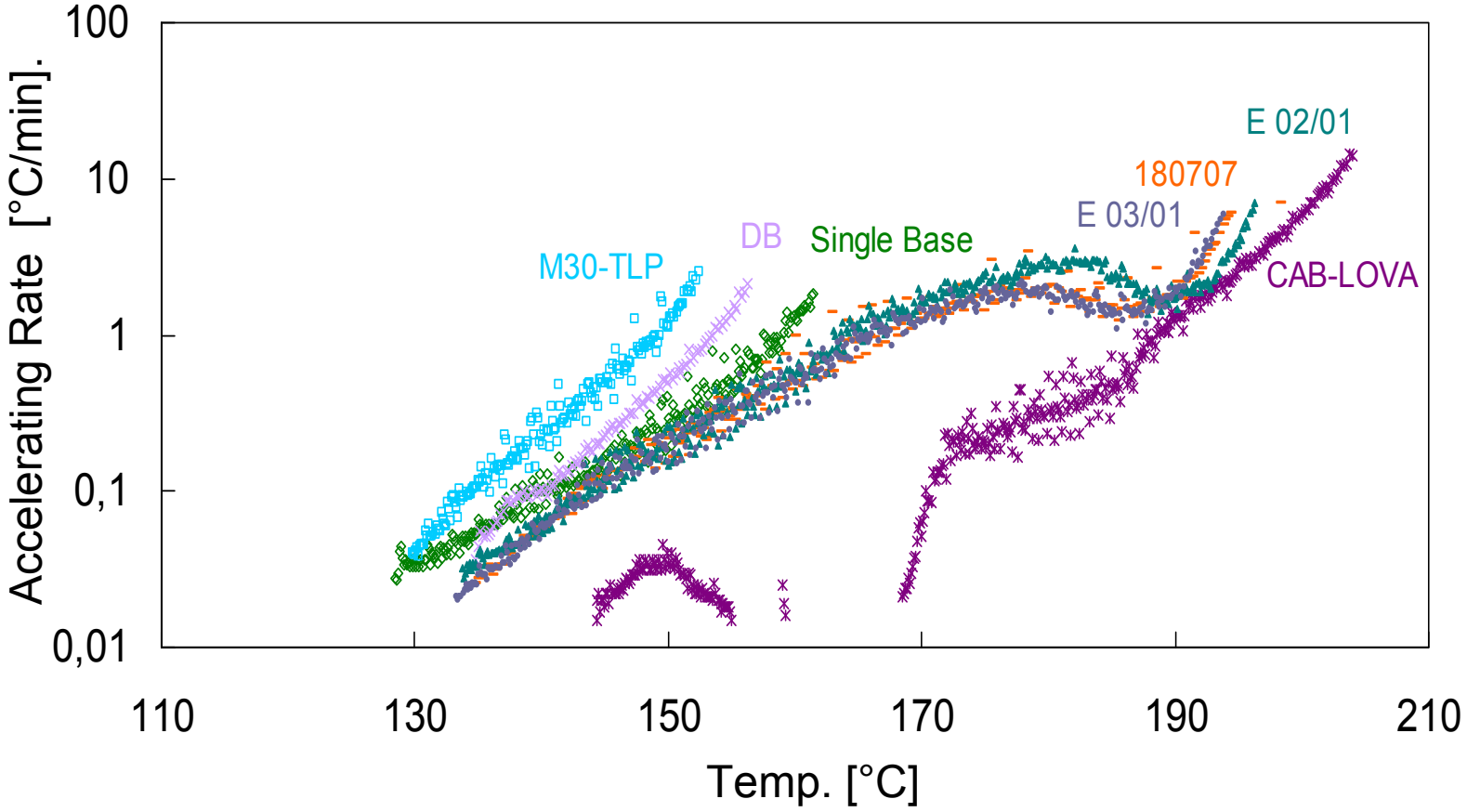
ARC
Accelerating Rate Investigations of DNDA - Propellants compared with CAB-Lova, M30, Single Base and Double Base



Mue

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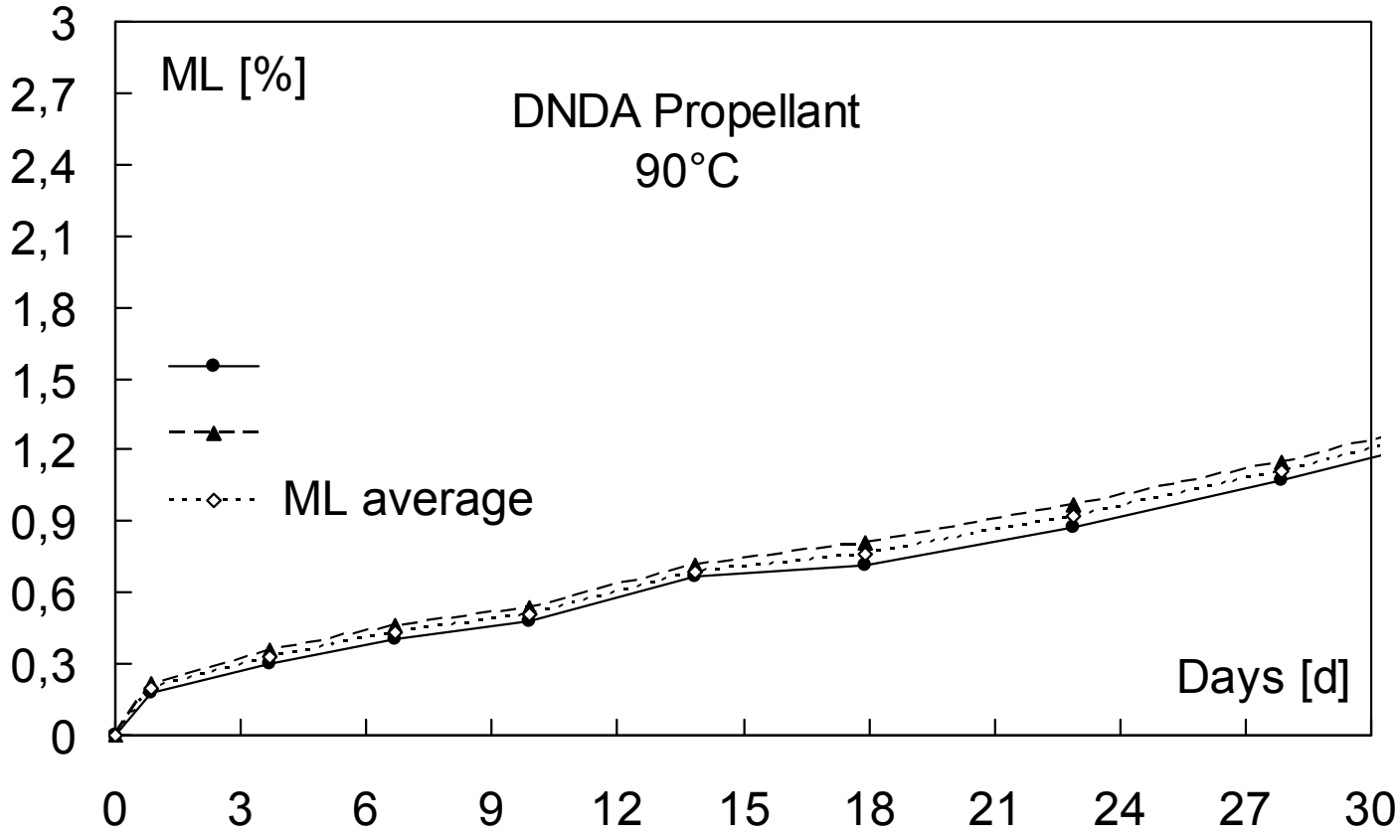
Long - Term Storage Stability at 90 °C
Mass - Loss over Time



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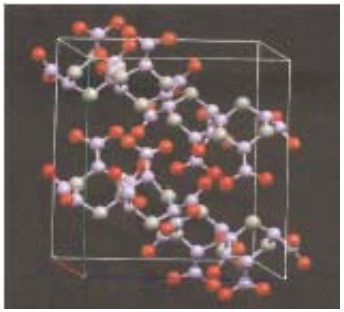
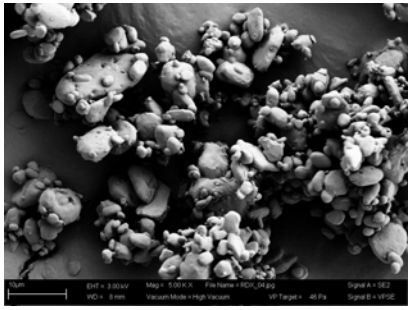
Pictures of RDX, FOX-7, FOX-12

RDX

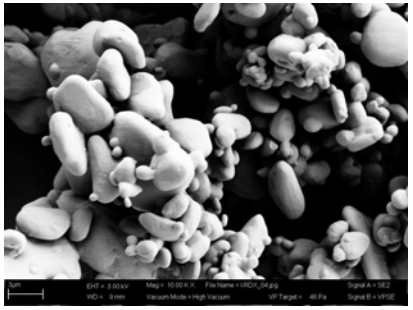
i-RDX



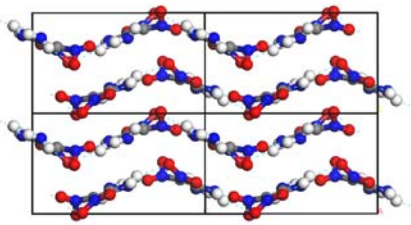
RDX

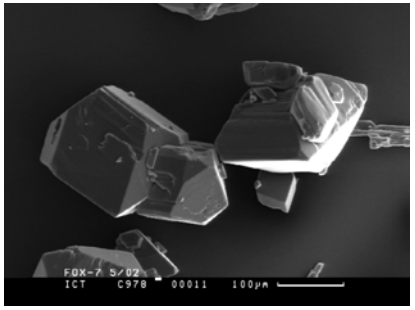


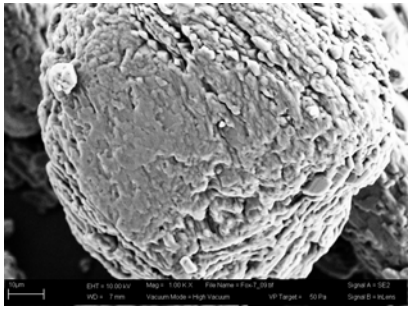
i-RDX



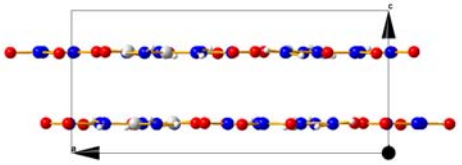
FOX-7

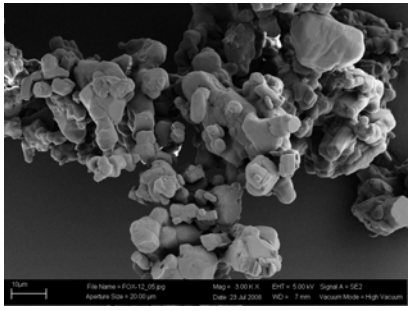


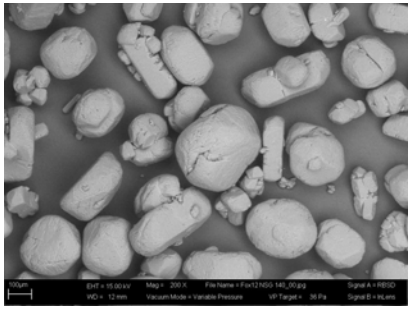




FOX-12







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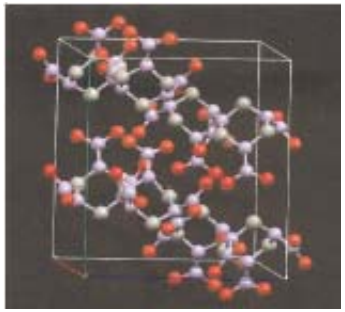
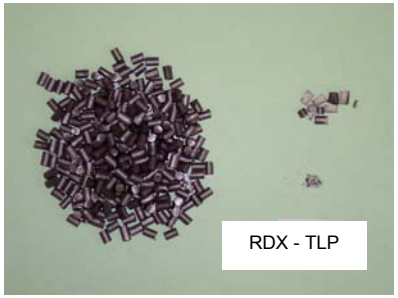
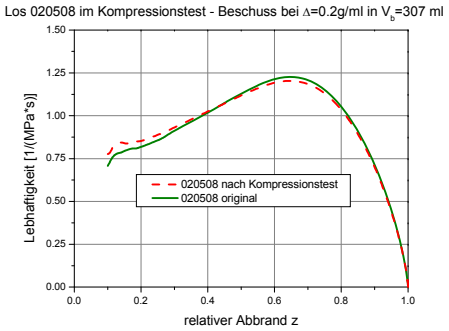
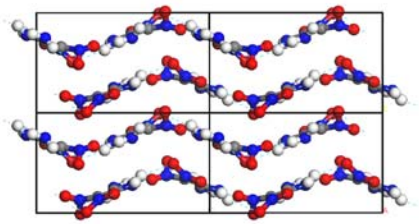
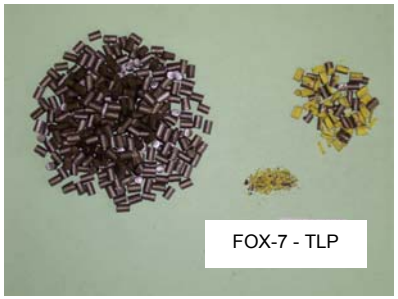
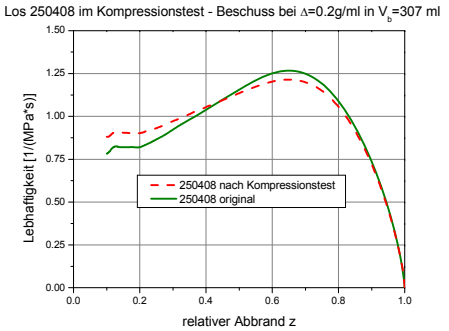
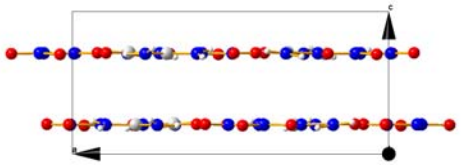
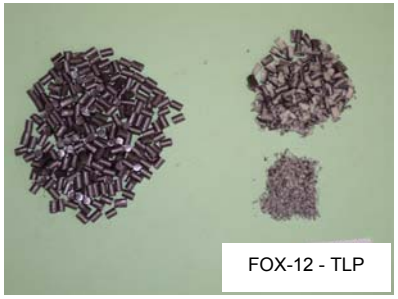
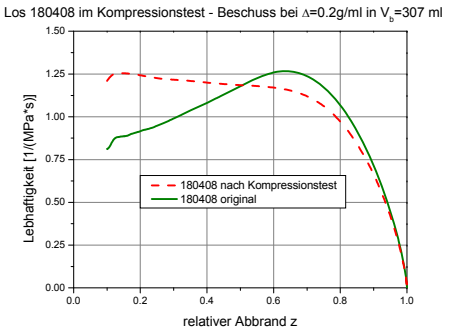
Influence of the Crystalline Components onto Compression Test

	Crystalline Energetics	Compression - Test	Vivacity
RDX			
FOX-7			
FOX-12			

Mue

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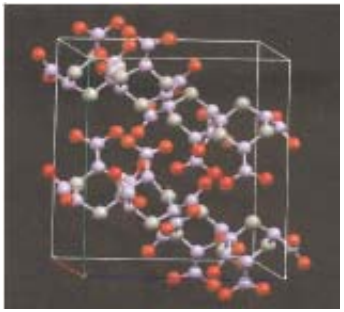
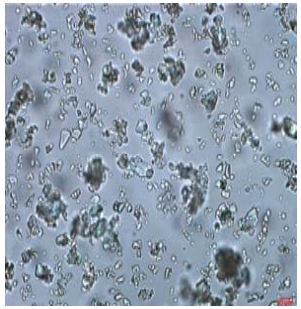
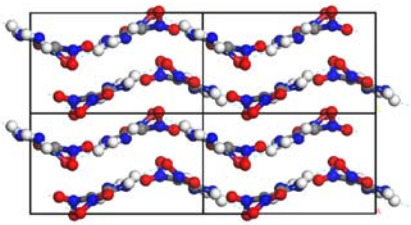
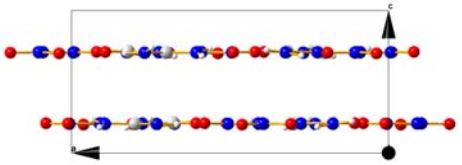
Influence of the Crystalline Components onto Shaped Charge Test

	Crystalline Energetics	Light Microscope Pictures	Shaped Charge Test Cart. 35mm
RDX			
FOX-7			
FOX-12			

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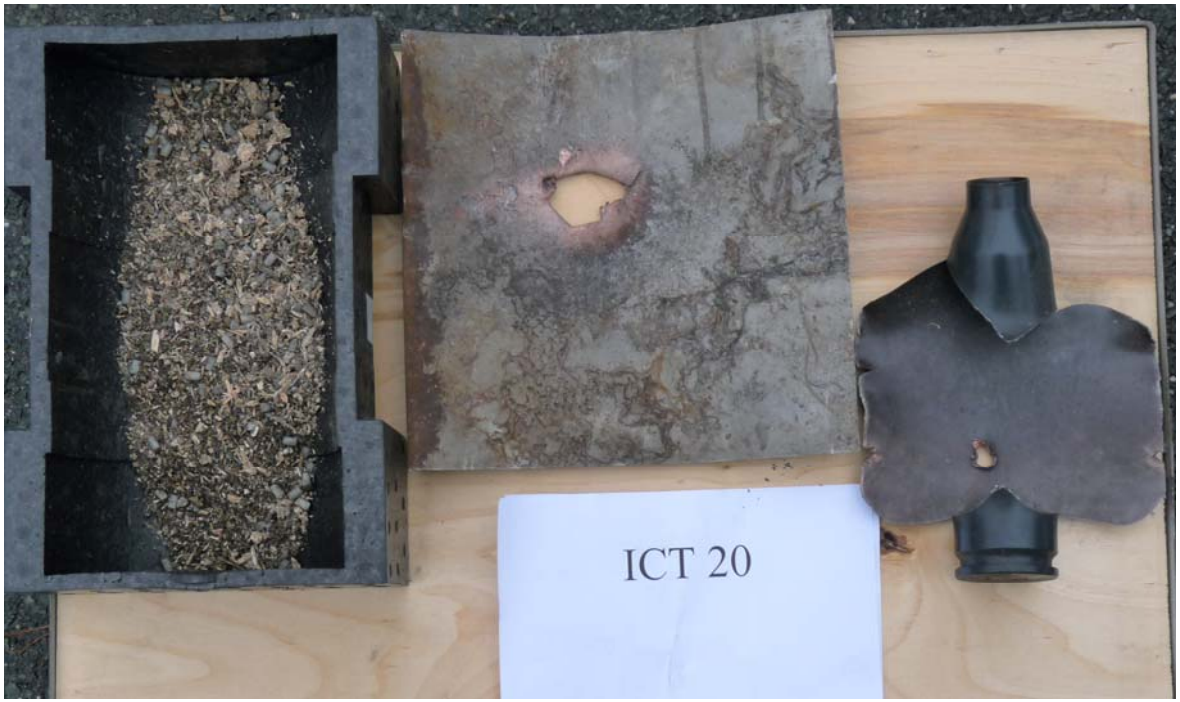
Shaped Charge Tests

DNDA Propellant ICT 1 (RDX), ICT 20 (i-RDX)



Class A

Class A

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Shaped Charge Test

DNDA Propellant ICT 3, Class B Test Result

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Shaped Charge Test

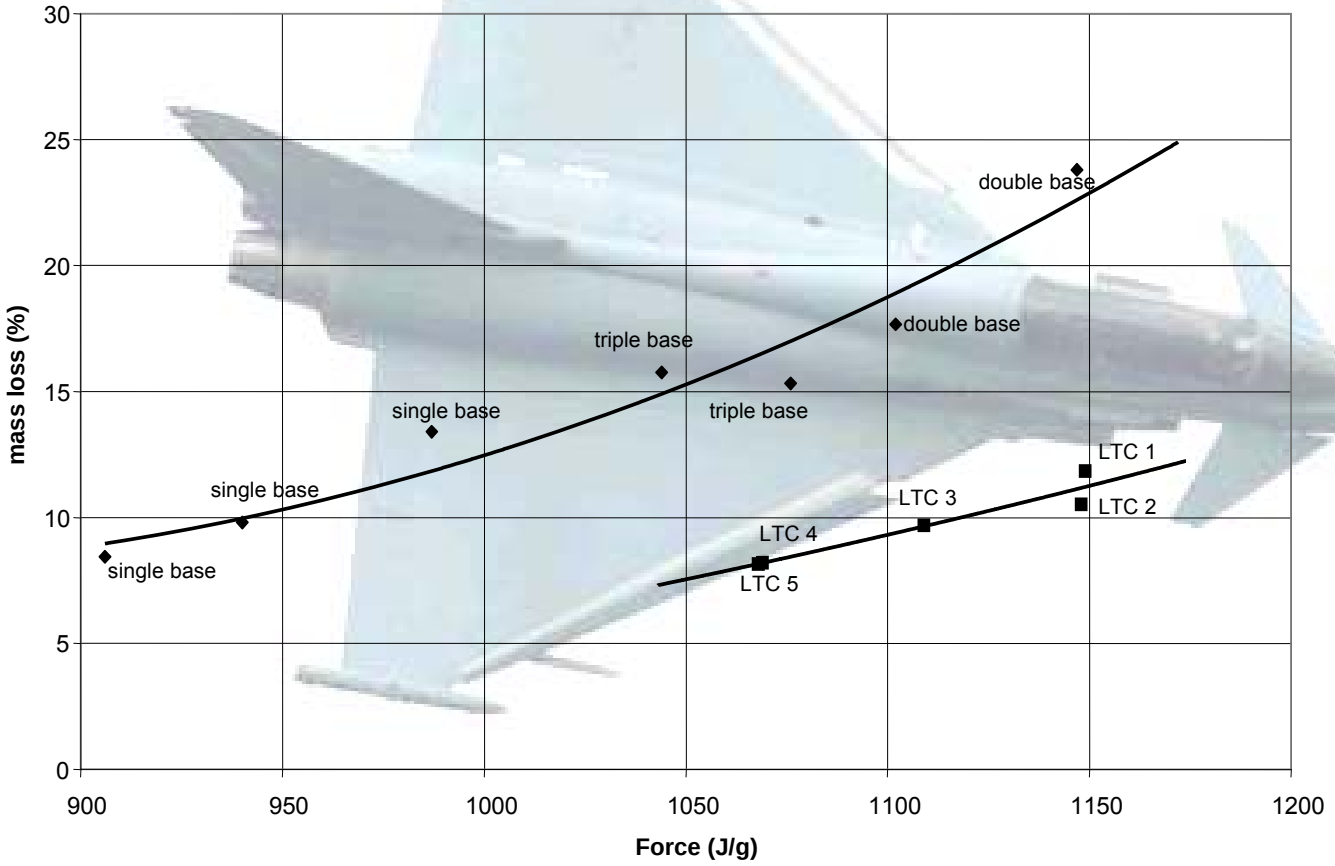
DNDA Propellant ICT 23, Class A Test Result

Sensitivity Data of different DNDA - Propellants

	FOX-12 Prop.	RDX Prop.	RDX Prop. ICT 1	FOX-7 Prop ICT 23	i-RDX Prop. ICT 20	RDX Prop. mod. DNDA ICT 3
Reaktion Class Shaped Charge Test 35 mm cal.	O no Reaction	A	A	A	A	B
Friction Sensitivity [N]	240	290	288	252	240	240
Impact Sensitivity [Nm]	6,0	6,5	6,0	7,5	6,0	5,0
Self-Ignition Temp. [°C]	~ 170 *	> 220 *	~ 220	~ 200	~ 216	~ 219
1“ Detonation Tube	* no Detonation					
MG 50 /12.7 mm cal.	*	*	IM Reaction Type 5 (MIL – STD 2105 B)			

* WIWEB Results

Erosivity of LTC Propellants and Conventional Propellants



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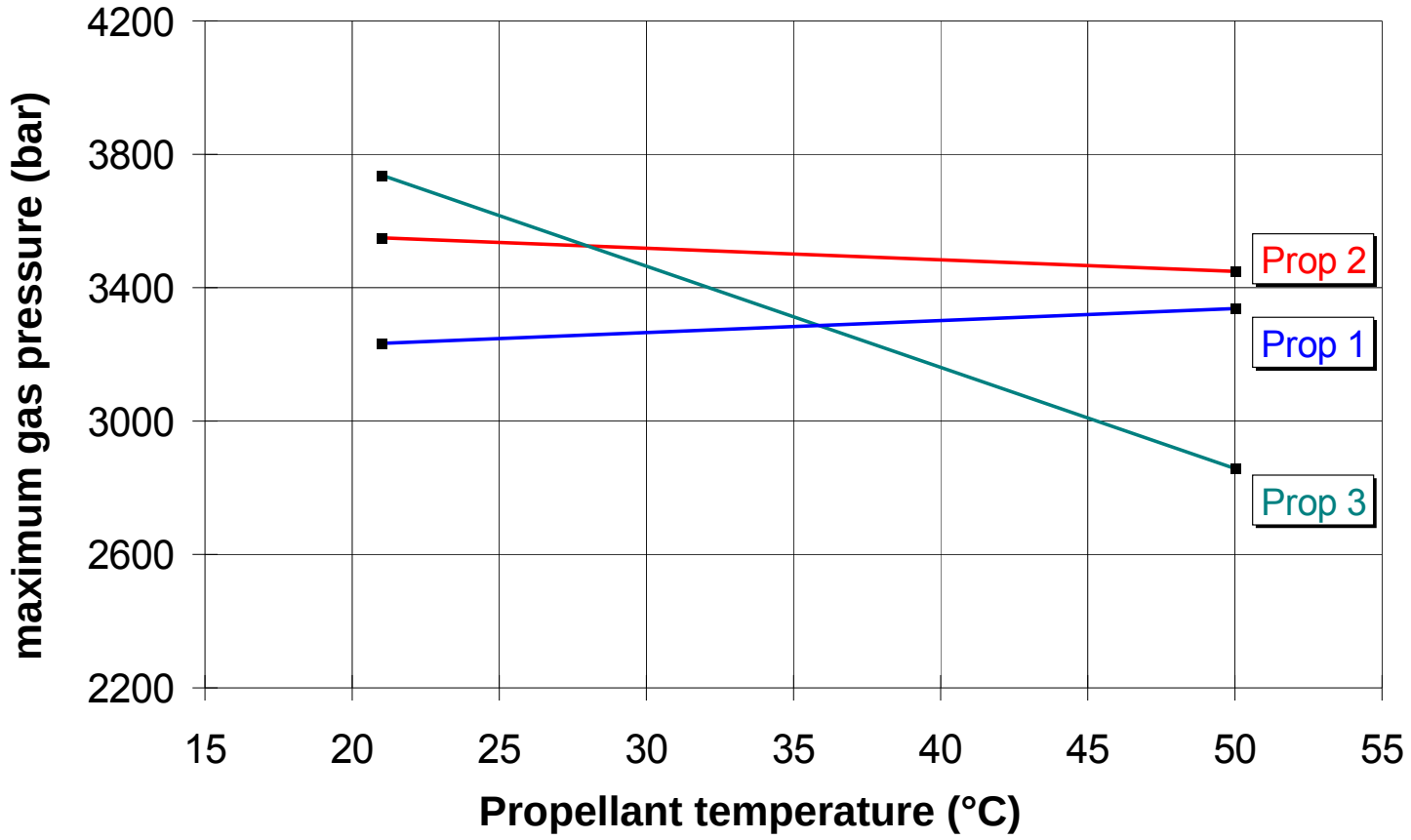
40 mm cal. Gun Firing Tests of 3 LTC Propellants based on DNDA, NC, RDX



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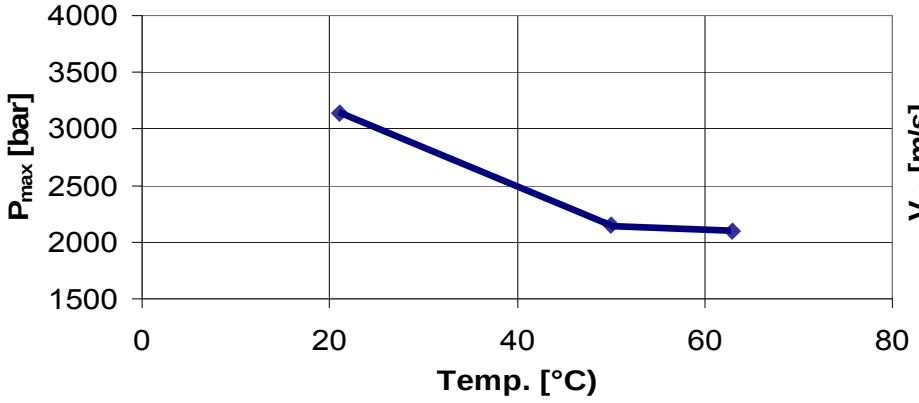
Test Firing Gun 40 mm cal.

Propellant based on Fox-7, NC, DNDA-5,7

gas pressure vs temp.

40 mm cal. L70, Los 080308,

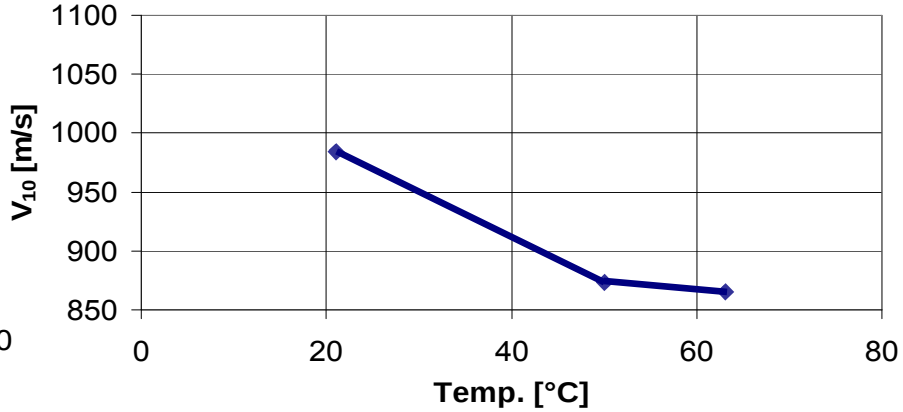
FOX-7 Propellant



muzzle velocity vs temp.

40 mm cal. L70, Los 080308,

FOX-7 Propellant



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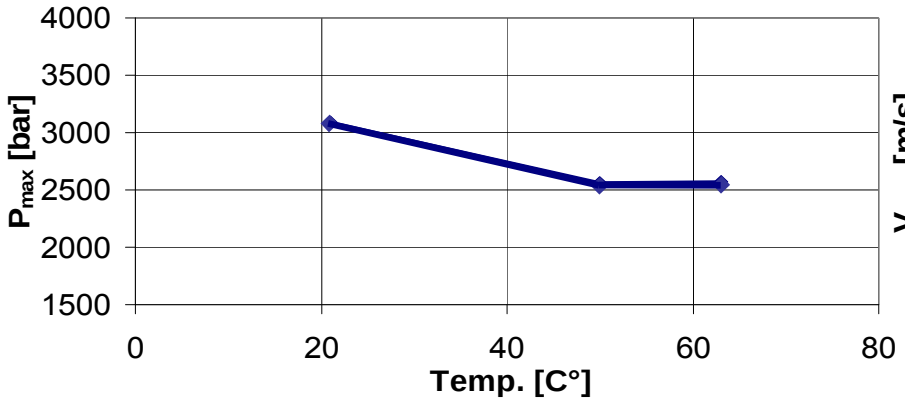
Test Firing Gun 40 mm cal.

Propellant based on FOX-12, NC, DNDA-5,7

gas pressure vs temp.

40 mm cal. L70, Los 140108,

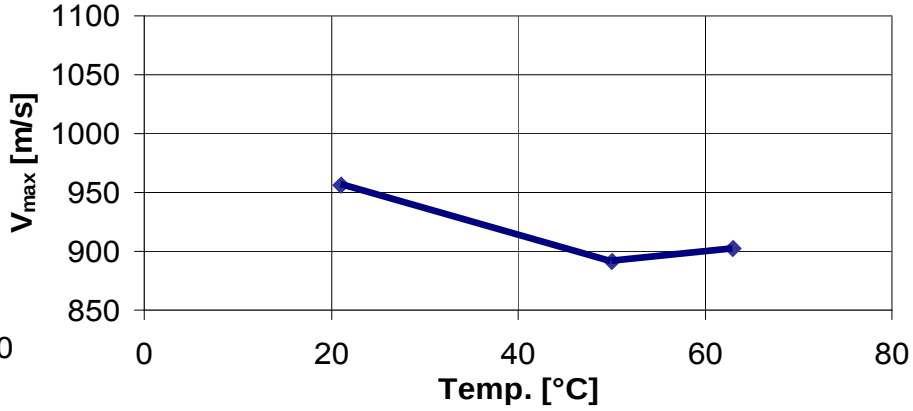
FOX-12 Propellant



muzzle velocity vs temp.

40 mm cal. L70, Los 140108,

FOX-12 Propellant



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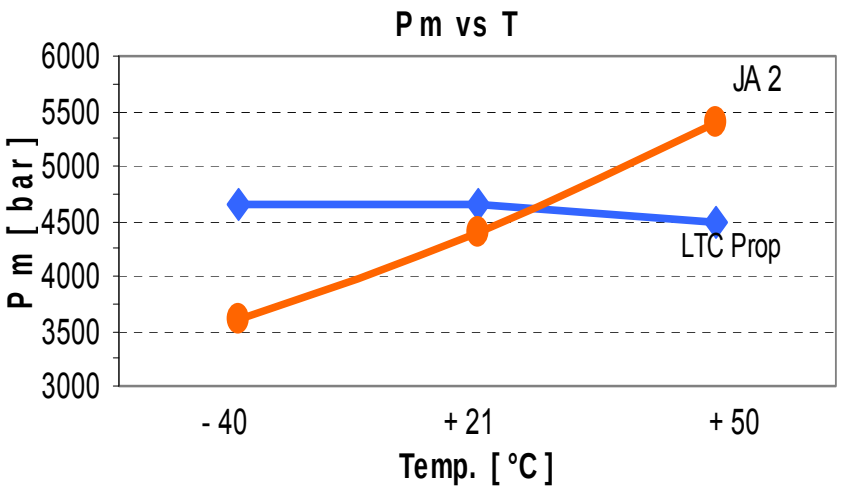
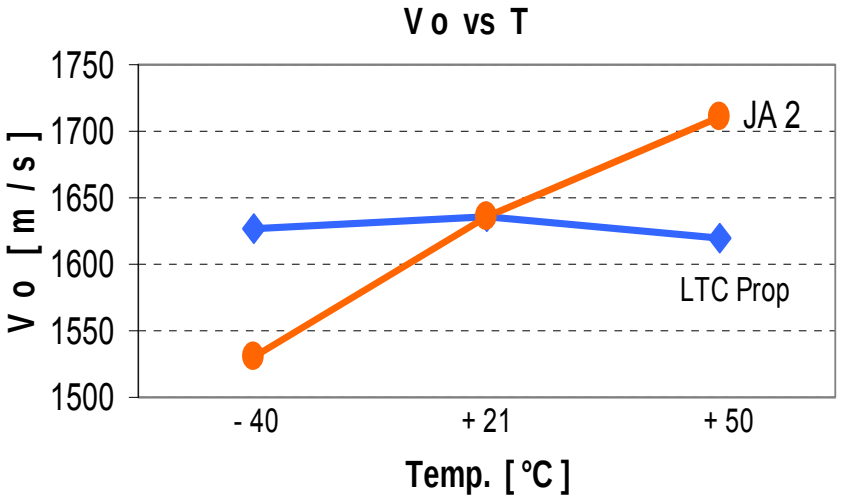
Test Firing in 75 mm cal. Model Gun (Diehl BGT)

Optimized propellant for firing at 21°C, RDX, DNDA based

gas pressure vs temp.



muzzle velocity vs temp.



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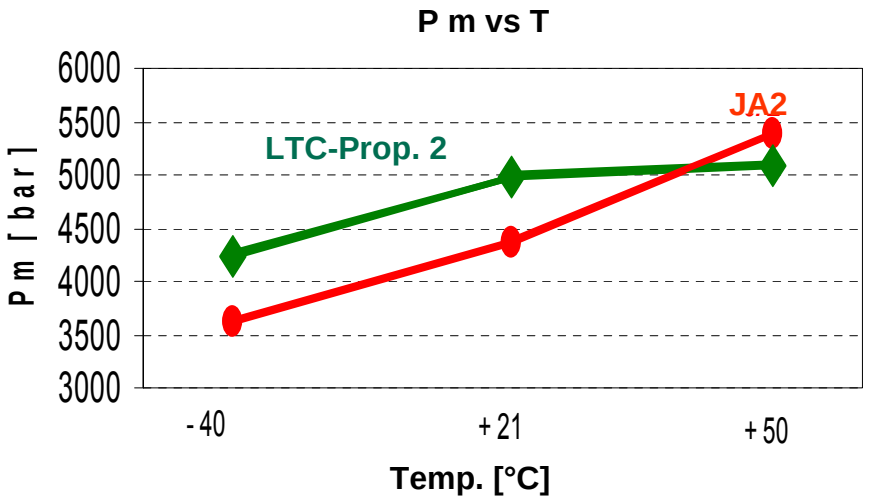
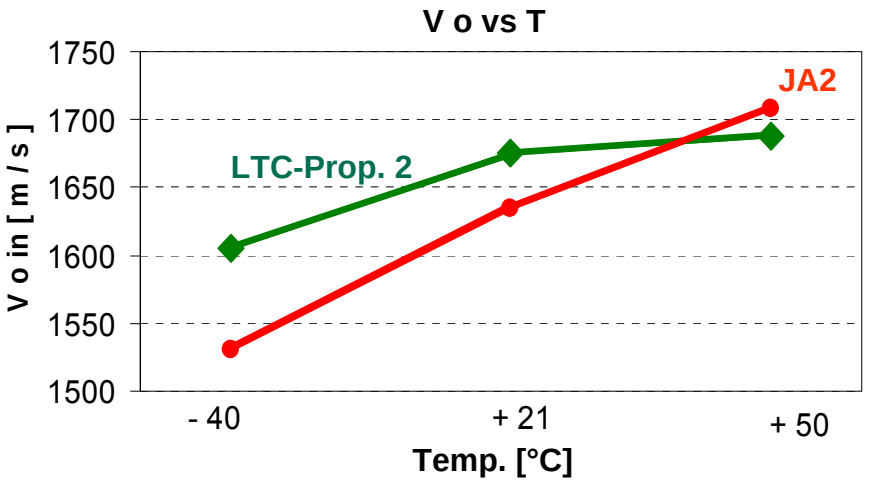
Test Firing in 75 mm cal. Model Gun (Diehl BGT)

Performance optimized propellant, RDX, DNDA based

gas pressure vs temp.



muzzle velocity vs temp.



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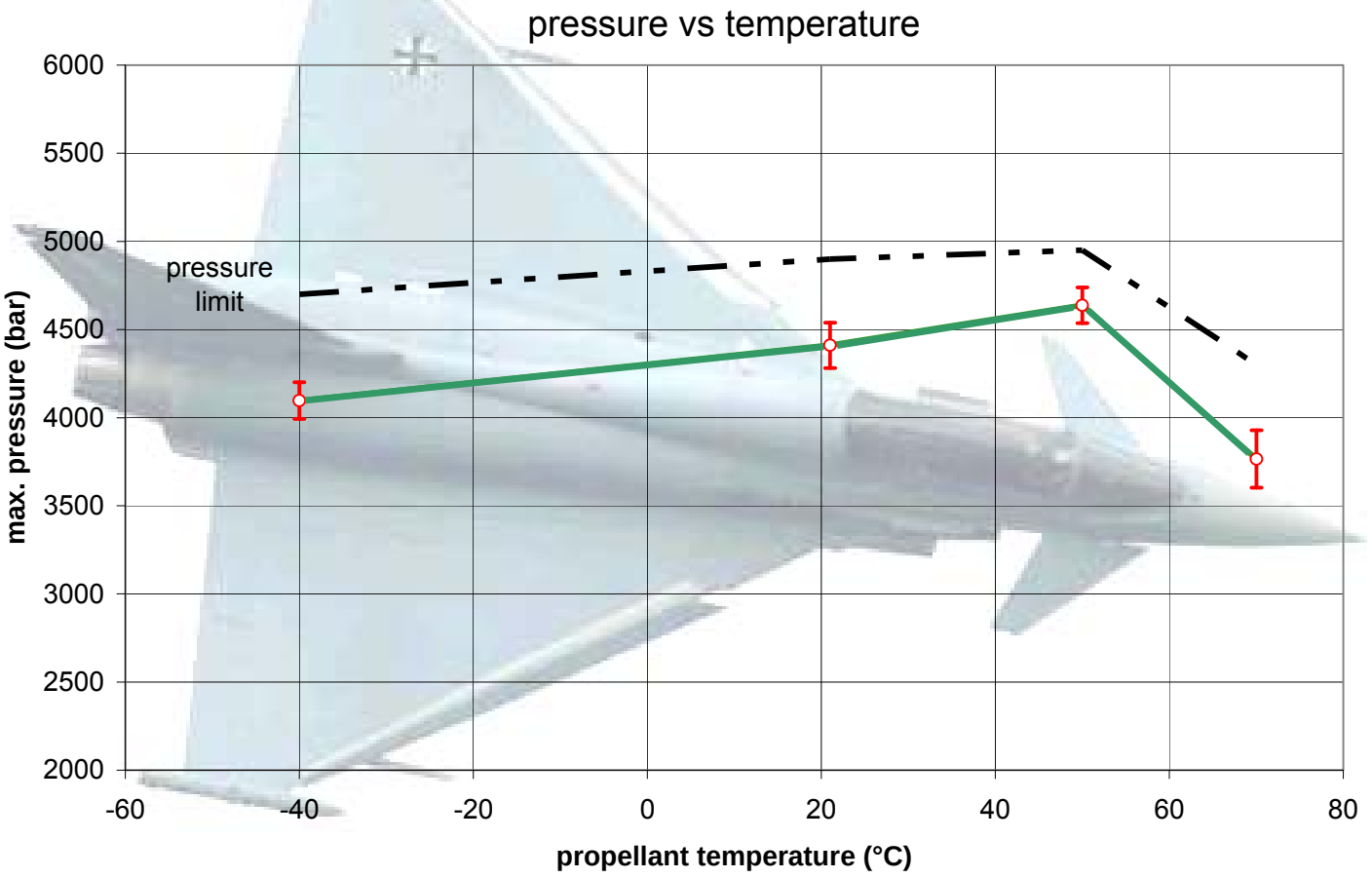
EF Propellant

Gun Firing 27 mm cal. Eurofighter



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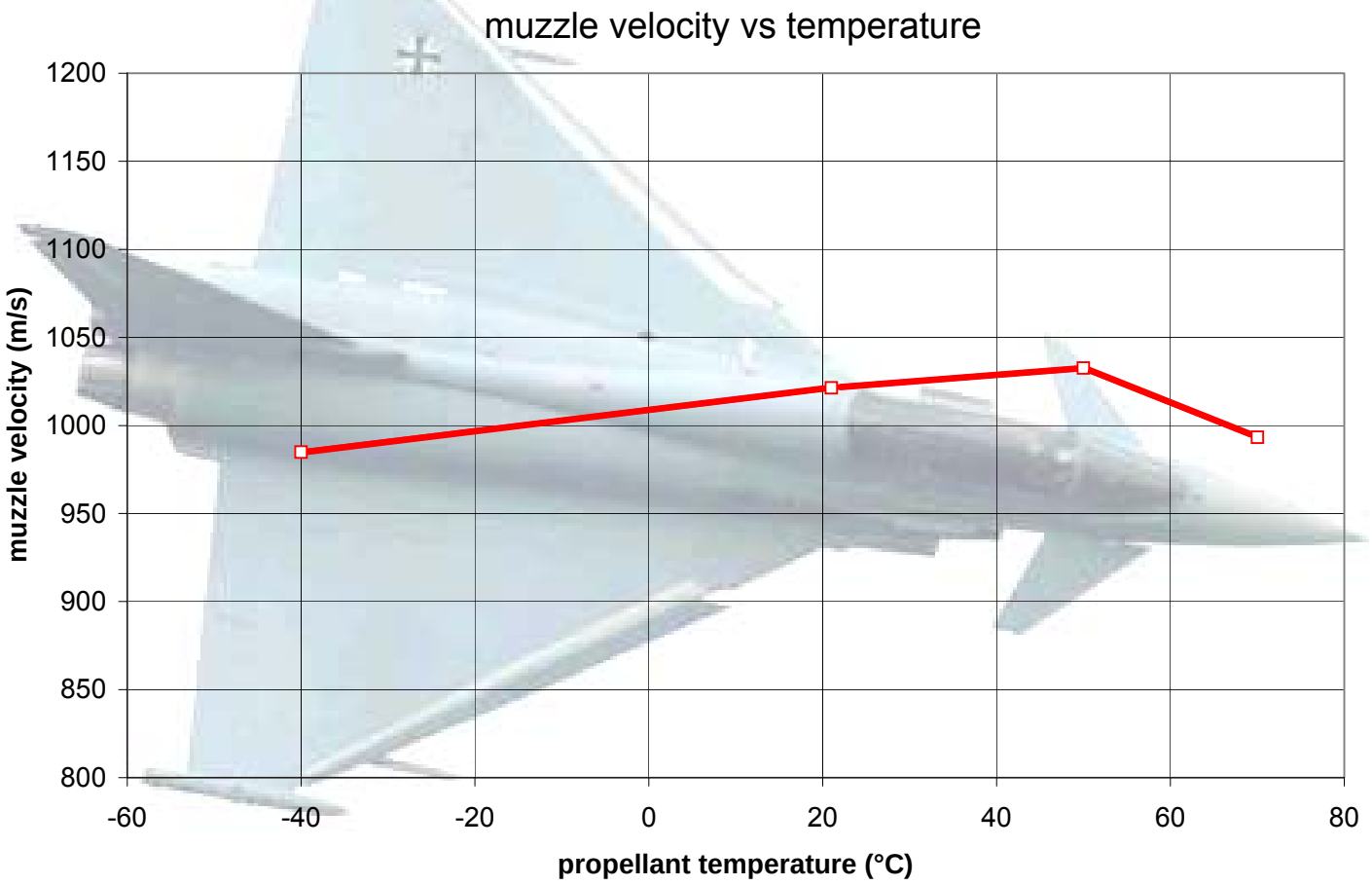
EF Propellant

Gun Firing 27 mm cal. Eurofighter



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EF Propellant 27 mm cal. Eurofighter PELE - Cartridge

Combustion Temperature	2900 K	Gun Erosion like Single Base Propellant
Force	1140 J/g	
Ignition Temperature	> 220 °C	

Cook - off Cartridge 27 mm cal.

27 mm Gun Tube Mauser, MATE (Mauser)

Q 5560 (Ref. Prop.)	125 °C	3,5 h	Ignition
EF - Propellant	125 °C	8,5 h	No Ignition

PELE Cartridge 27 mm cal.

PELE = **P**enetrator with **E**nhanced **L**ateral **E**fficiency

EF DNDA
gun propellant

PELE® projectile DM 83 and
DM 93 (with tracer)

Results & Conclusion

- LTC Propellants based on DNDA-5,7 and RDX for a wide Caliber - Range
- Excellent Shaped Charge Test Results (Reaction Class A)
- High Self-Ignition Temperature > 220 °C
- Insensitive, Reaction Type 5 (MIL - STD 2105 B)
  IM Characteristic
  MG 12.7 mm cal. firing on Steel Tube with propellant
- Excellent Long-Term Stability
- Low Combustion Temperature at High Force and Low Gun Tube Erosion
- Less Sensitive in Hot Gun Tube (MATE)
- Propellant Charge for Eurofighter Gun, 27 mm cal. PELE Cartridge