

Main component(s)	Curing agent(s)	Impact sensitivity [J]	Friction sensitivity [N]	Electric spark discharge sensitivity [J]	Ratios of the components / main component and curing agent	Comments and methodology notes	Ref.
GAP (commercial)	-	>9,04	>444,8	-	-	Bureau of Explosives: Impact 0/10 80 inch-pound (9,04J) ( <a href="http://www.uteccorp.com/wp-content/uploads/2017/10/BOE.pdf">http://www.uteccorp.com/wp-content/uploads/2017/10/BOE.pdf</a> ) Test method 1011 as detailed in MIL-STD 1751A) friction 0/10 100 pounds (444,8 N)	7
MWCNT-HTPB + MWCNT-Acyl-GAP (NCO/OH=0,8; 50% Acyl-GAP)	CI1, CI2	>40	>360	>5	-		24
Propellants based on MWCNT-HTPB	CI1, CI2	3-4	40-50	-	-	80% solid loadings, NH4ClO4, Al, exact composition not given	
Propellants based on MWCNT-HTPB + MWCNT-Acyl-GAP (NCO/OH=0,8; 50% Acyl-GAP)	CI1, CI2	4.5	210	-	-	80% solid loadings, NH4ClO4, Al, exact composition not given	
GAP-co-azidoTHF	-	0%	0%	0.181	-	Impact sensitivity: QJ2913-1997 standard; Friction sensitivity: QJ1469-1988 standard, Electrical spark discharge sensitivity: QJ 3039-1998 standard (E50%)	41
GAP	CI4	>40	>360	-	"cured GAP" + butanediol + N-(2-cyanoethyl)diethanolamine   GAP = soft segment, rest = hard segment = 30%   ETPE X consists of X% ethanolamine in butanediol/ethanolamine mixture	Insensitive for all ETPE X types.	49
poly(2,2,2-trifluoro-ethoxymethyl epoxy-r-glycidyl azide)	CI1	>129cm	-	-	NCO/OH = 1	H50 / drop hammer impact sensitivity test for energetic polymer was developed. The weight of the hammer was 3 kg and the drop height was between 0–1.29 m	50
GAP	CI1	42,2cm	-	-	NCO/OH = 1		
GAP	CI3	7.00	>360	-	-	Impact and friction sensitivity tests were carried out according to STANAG 4489 18 and STANAG 4487 modified instructions using a BAM (Bundesanstalt für Materialforschung) drop hammer and friction tester. Electrostatic sensitivities were measured with a OZM small scale electrostatic discharge tester.	58
BAMP	diisocyanatoethane	40.00	>360	1.5	-		
BAMP	CI3	40.00	>360	-	-		
DNPD	diisocyanatoethane	40.00	>360	-	-		
DNPD	CI3	40.00	>360	1.5	-	Impact and friction sensitivity tests were carried out according to STANAG 4489 and STANAG 4487 modified instructions using a BAM (Bundesanstalt für Materialforschung) drop hammer and friction tester. Compounds used as plasticisers for GAP	60
Esters of BAMP	-	>40	>360	-	-		
Esters of DNPD	-	>40	>360	-	-	BAM friction apparatus was used	62
Bis(2,3-diazidopropoxy)alkanes	-	-	>360	-	-		
GlyN dimer	-	-	>360	-	-		
GNAP	-	40	>360	-	Theoretical Vdet (7165m/s), from EXPLO 5 V6.02   ESD sensitivity is mentioned but no values are given	Impact and friction sensitivity tests were carried out according to STANAG 4489 and STANAG 4487 modified instructions using a BAM (Bundesanstalt für Materialforschung) drop hammer and friction tester. Electrostatic sensitivities were measured with a OZM small scale electrostatic discharge tester	71
NC/NG modified with GAP	-	6.92	-	-	0%GAP in the GAP/NC/NG powder	The standard impact tester was used with exchangeable anvil; the amount of tested substance was 50 mm 3 ; drop hammers of 2 kg mass were used. The sensitivity observed was expressed as the drop energy, Edr, vs. percentage of initiation. Only the 50 % probability of initiation is used in this article (E50)	85
NC/NG modified with GAP	-	7.1	-	-	10%GAP in the GAP/NC/NG powder		
NC/NG modified with GAP	-	9.05	-	-	20%GAP in the GAP/NC/NG powder		
NC/NG modified with GAP	-	9.34	-	-	30%GAP in the GAP/NC/NG powder		
NC/NG modified with GAP + GAP + other components = propellant slurry	-	6.86	-	-	0%GAP in the GAP/NC/NG powder and 4.0-5.2 "free" GAP added to the mixture		
	-	8.29	-	-	10%GAP in the GAP/NC/NG powder and 4.0-5.2 "free" GAP added to the mixture		
	-	10.23	-	-	20%GAP in the GAP/NC/NG powder and 4.0-5.2 "free" GAP added to the mixture		
	-	13.11	-	-	30%GAP in the GAP/NC/NG powder and 4.0-5.2 "free" GAP added to the mixture		
RDX (95% w/w) coated with NC (3%) and GAP (2%)	-	40,74cm	-	-	-	The impact sensitivity was surveyed by a home-built type-12 drop hammer apparatus. The test was carried out by the Chinese National Military Standard GJB-772A-97, standard method 601.2 [17]. The samples (35±1 mg) were subjected to an impact of a 2.500±0.002 kg hammer at various heights using an up-and-down method. The critical drop height of 50% explosion probability H50	93
RDX	-	23,40cm	-	-	-		
RDX (pure)	-	12,8cm	-	-	RDX = 100%	The impact sensitivity was measured by 5 kg standard drop-hammer [15, 16], and the charge weight was 35 mg. Detected by China Ordnance Industries booster charge performance testing center at room temperature. Firstly, the samples were placed at the bottom of the drop hammer. Secondly, 5 kg weight drop hammer was released when it was promoted to a certain height. Thirdly, the hammer hit the target on the ground, resulting in an explosive. An average value of impact sensitivity was obtained based on the results from three tests. The impact sensitivity value represents the height from which the dropping of a 5-kg weight will result in an explosion in 50 % of the trials.	96
RDX/GAP (blend)	CI5, NCO/OH = 1,5	15,59cm	-	-	RDX = 40%		
RDX/GAP (nanocomposite)	CI5, NCO/OH = 1,5	30,2cm	-	-	RDX = 40%		
CI-20/GAP	toluene diisocyanate	38,2cm	-	-	CL-20 (ε type) was provided by Liaoning Qingyang Chemical Industry Co.Ltd. (Liaoning, China); GAP, Mn = 3380, with a hydroxyl value of 0.646 mol/g was from Luzhou North Chemical Industry Co. Ltd   82% CI-20, 14% GAP, 1,5% toluene diisocyanate, 2,5% others   shock sensitivity 7,74mm (card gap)   Vdet (measured) = 7364m/s   critical diameter <0,6mm	The drop weight was 5.000 ± 0.005 kg, and sample mass was 35 ± 1 mg. The result is represented with the characteristic height (H 50 ). The larger the value of H 50 , the lower the impact sensitivity (National Military Standard of China, China Weapon Industry Corporation). The shock sensitivity test assembly is shown in Fig. 2. The experimental principle is that a shock wave was generated by the explosion of standard donor explosive column. Then the shock wave was attenuated by the card gap of polymethyl methacrylate. Finally, the attenuated shock wave acted on the test sample. The shock sensitivity and its safety were evaluated by the thickness of the card gap.	106
CI-20 (pure)	-	15,9cm	-	-	shock sensitivity 42,11mm (card gap)   Vdet 9500m/s		
CI-20/GAP (85% CI-20)	CI2	37,2cm	-	-	Used for DIW (direct ink writing)   CL-20 explosive (purity=99.6 %, particle size 20-50 μm) synthesised   Glycidyl azide polymer binder (GAP, Number-average molecular weight, Mn = 4000, with a hydroxyl value of 1.412 mmol/g, Liming Research Institute of Chemical Industry), Desmodur N100 commercial   critical diameter <0,4mm	The impact sensitivity was determined by using a BAM fall hammer apparatus. A 30 ± 1 mg sample was placed steel anvils and was hit by a 2 ± 0.05 kg hammer. The environmental temperature and humidity are at 23 °C and 20 %. The results are represented with the characteristic height ( H 50 )	108
CI-20	-	21,1cm	-	-	-		
GAP/DNTF	toluene diisocyanate	38,3cm	0%	-	DNTF was supplied by Gansu YinGuang Chemical Industry Co. Ltd. GAP resin with a molecular weight close to 3300 was produced by Luzhou North Chemical Industry Co. Ltd.   DNTF 85%, GAP 11%,	In the impact sensitivity test, an ERL type 12 drop hammer apparatus was used in which the mass of the drop weight was 2.500 ± 0.005 kg and the sample mass was 35 ± 1 mg. All tests were performed at room temperature. Friction sensitivity was measured according to the explosion probability method	109

DNTF (2-3 μm)	-	25,6cm	13%	-	toluene diisocyanate 1,6%, others 2,4%   critical diameter < 0,5mm, Vdet = 7362m/s	of GJB-772 using a Swing Friction Sensitivity Tester
DNTF (15-20 μm)	-	25,0cm	12%	-		
HMX	-	25,7cm	100%	-		