

Index

a

- A_nB star-type energetic thermoplastic elastomers (TSETPE) 209
 3-acetyl-4-nitrofurazan 348
 adiabatic equilibrium composition 387
 adiabatic time-to-explosion, of energetic materials 307
 adipoyl chloride (AdCl) 211
 aliphatic precursors 144–146
 2-alkyl-4-alkylamino-5-nitro-1,2,3-triazole-1-oxides 351
 3-alkylamino-4-nitrofuraxans 351
 alkyl-bridged 5*H*-tetrazoles 116
 alkynyl-terminated poly(ethyleneoxide-tetrahydrofuran) (ATPET) 207
 all-nitrogen cluster N_4 93
 all-nitrogen cluster N_6 93–94
 all-nitrogen crystals composed of N_8 94
 all-nitrogen crystals composed of N_{10} 95
 all-nitrogen HEDMs with Cubic Gauche structure 96–97
 amidoxime 158, 159, 334
 aminated bis-pyrazole 142
 aminated diimidazole 142
 1-(2-aminophenyl)-pyrazol-3-ones 141
 1-amino-2-(4-aminofurazan-3-yl)gloxime 352
 1-aminotetrazol-5-one (ATO) 263
 2-(5-amino-1*H*-tetrazol-1-yl)acetonitrile 249
 3-(4-aminofurazan-3-yl)-1,2,4-oxadiazole-5-amine 336
 3-(4-aminofurazan-3-yl)-4-(4-nitrofurazan-3-yl)-1,2,4-oxadiazole 334
 3-(4-aminofurazan-3-yl)-4-(4-nitrofurazan-3-yl)furazan 357
 3-(4-aminofurazan-3-yl)-4-(4-nitrofurazan-3-yl)furoxan 354
 3-amino-1,2,4-triazolium salts 256
 3-amino-4-(4-aminofurazan-3-yl)furoxan 345, 352, 353
 3-amino-4-(5-amino-1,3,4-oxadiazol-2-yl)furazan 342
 3-amino-4-(chlorodinitromethyl)furazan 365
 3-amino-4-(picrylamino)furazan 345
 3-amino-4-chloroximinofurazan 365
 3-amino-4-nitrofurazan 346, 348
 4-amino-1,2,5-oxadiazole-3-carbohydroximoyl-chloride intermediate 266
 4-amino-3,7,8-trinitropyrazolo-[5,1-*c*][1,2,4]triazine (PTX) 53
 4-amino-3-(4-aminofurazan-3-yl)furoxan 346, 352
 4-amino-3-chloroximinofurazan 345, 351, 353
 4-amino-3-cyanofuroxan 254
 4-amino-4'-nitro-3,3'-azoxybisfurazan 348
 4''-amino-4-(((2,2,2-trinitro-ethyl)amino)-[3,3',4',3''-ter(1,2,5-oxadiazole)]-2'-oxide 355

- 4-aminofurazan-2-*ONN*-
azoxyazidofurazan 350
- 4-aminofurazan-3-carbohydrazide 342
- 4-aminofurazan-3-carbonitrile 335
- 4-aminofurazan-3-carboxamidoxime
335, 345, 361
- 4-aminofuroxan-3-carboximidoyl chloride
361
- 5-(4-amino-(1,2,5)oxadiazolyl)-5*H*-
[1,2,3]triazolo[4,5-*c*][1,2,5]
oxadiazole 349
- 5-(4-amino-1,2,5-oxadiazol-3-yl)-
1-hydroxytetrazole 263
- 5-amino-1*H*-tetrazole (ATZ) 251
- 5-amino-1*H*-tetrazole 242, 265
- 5-amino-3-nitro-1,2,4-oxadiazole 333
- 5-amino-4*H*-1,2,4-triazol-1-ium salts
266
- 5-aminotetrazole 197
- 5-aminotetrazolium (ATZ) 80
- 7-*R*-amino-7*H*-tris[1,2,5]oxa-diazolo
[3,4-*b*\,3',4'-*d*\,3'',4''-*f*]azepine-
1-oxide 356
- amino-BPTAP, synthesis 381
- aminofurazan 158
- aminoguanidinium 25, 33, 80, 266, 273,
337, 341, 347, 355, 356
- aminoguanidinium bicarbonate (AG)
337
- amino/hydrazine-tetrazole energetic salts
263
- amino/hydrazine-tetrazole nitrogenous
salts 279
- aminonitroguanidine (ANG) 337
- amino-(*tert*-butyl-*NNO*-azoxy)triazoles
158
- aminotriazoles 158, 382
- ammonium/barium salt 259
- ammonium dinitramide (ADN) 190, 192
- ammonium 4-nitrofurazan-3-hydroxide
348
- ammonium 5-(fluorodinitromethyl)-
2*H*-tetrazolate 253
- ammonium 5-nitrotetrazolate
hemihydrate 268
- ammonium perchlorate 190, 239, 285,
290
- annulated 1,2,3,4-tetrazines 142
- anthracene-like TBTOs 152
- aqueous NH₃ 338
- aromatic C-NO₂ containing polymers
230
- aromaticity, system of 169
- arylazo-pyrazoles 141
- 5-aryl-3-methylpyrazolo-tetrazines 141
- arylpentazoles (ArN₅) 2
- 5-AT-based colored smoke formulations
407
- atomistic structure–macroscopic property
76
- atom-transfer radical polymerization
(ATRP) 204
- aza-TACOT
structure 378
synthesis 378–383
- azide-functionalized hydroxyl-terminated
poly(butadiene (azide-HTPB)
211
- 1-(2-azidoethyl)-1*H*-tetrazole (**1-AET**)
117
- 1-(2-azidoethyl)-1*H*-tetrazole (**1-APT**)
117
- 1-azidopropyl-5*H*-tetrazole (**1-APT**) 118
- 2-azidophenyl-substituted
triazolotetrazine 162
- 3-(4-azido-furazan-3-yl)-4-(4-nitrofurazan-
3-yl)furoxan 356
- 3-(4-azidofurazan-3-yl)-4-(4-nitrofurazan-
3-yl)furazan 358
- 3-azido-5-guanidino-1,2,4-oxadiazole
333
- 3-azido-methyl-3-methyloxetane
(AMMO) 218
- 5-(4-azido-(1,2,5)oxadiazolyl)-5*H*-[1,2,3]
triazolo-[4,5-*c*][1,2,5]oxadiazole
349
- 5-azido-6-(1,2,3-triazol-2-yl)-BTDO 153
- 6-azido-5-triazolyl-BTDO 150
- 6-azido-7-nitro-BTDO 157
- 7-azido-5-bromo-BTDO 156

- 8-azido-7-nitro-BTDO 156
- azido-deoxy cellulose dinitrate (CAN) 213
- azido-deoxy cellulose mononitrate (AC) 213
- azido fluoropolymers 216
- azido plasticizers 219
- azido-rich energetic polymers and plasticizers 202
- azo-1,3,4-oxadiazoles 342
- 2,2'-azobis(2-methylpropionitrile) (AIBN) 190
- 5,5'-[azobis(1,2,5-oxadiazol-4,3-diyl)-bis[*1H*-[1,2,3]triazolo[4,5-c][1,2,5]-oxa-diazolium] (inner salt) 350
- azo-2,2'-bis-1,3,4-oxadiazole-5,5'-(4-nitramino-1,2,5-oxadiazol-3-yl) 343
- azo-2,2'-bis-1,3,4-oxadiazole-5,5'-(4-nitro-1,2,5-oxadiazol-3-yl) 343
- azo-dimer 352
- azole bridge tetrazole-containing compound 251
- azoxyalkenes 145
- b**
- band spectrum 397
- barium bis-tetrazolate salt 400
- benzoannulated 1,2,3,4-tetrazine 1,3-dioxides
- benzotetrazine 1,3-dioxide annulated with one more tetrazine 1,3-dioxide ring 150
- benzotetrazine 1,3-dioxides annulated with tetraazapentalenes 151
- benzotetrazine 1,3-dioxides with functional groups 147
- benzotetrazine 1-oxides 170
- benzo-1,2,3,4-tetrazine 1,3-dioxides (BTDOs) 154, 172
- benzotetrazine 1,3-dioxides (BTDOs) 139, 141, 147
- annulated with one more tetrazine 1,3-dioxide ring 150
- annulated with tetraazapentalenes 151
- with functional groups 147
- benzotrifuroxan (BTF) 67
- 1-(benzyloxy)-1,2,3-triazole 143
- benzylpentazole (BzN₅) 3, 45
- [5,5]-bicyclic-backbone-based energetic compounds 49
- Billiard reaction 150
- 1,2-bis(3-nitro-1-(1*H*-tetrazol-5-yl)-1*H*-1,2,4-triazol-5-yl)diazene (BNTD) 269
- 2,2-bis(azidomethyl)propane-1,3-diol (BAMP) 213
- 2,2-bis(azidomethyl)propane-1,3-diol (DAP) chain extender 209
- 2,2-bis(azidomethyl)propane-1,3-diyl diacetate (BAMP) 226
- 2,5-bis(3-amino-2,4,6-dinitrophenyl)-1,3,4-oxadiazole 340
- 2,5-bis(dinitromethyl)-1,3,4-oxadiazole 341
- 2,5-bis(dinitromethyl)-2*H*-tetrazole 246
- 2,5-bis(trinitromethyl) derivative 341
- 2,5-bis(trinitromethyl)-1,3,4-oxadiazole 341
- 3,3-bis-azidomethyloxetane (BAMO) 199, 203
- 3,3-bis(azidomethyl)oxetane-tetrahydroxyl-furan (BAMO-THF) copolymer 219
- 3,3-bis-(tosyl-methyl)oxetane (BTMO) 200
- 3,4-bis(4-aminofurazan-3-yl)-furazan 357
- 3,4-bis(4-aminofurazan-3-yl)furoxan 353
- 3,4-bis(4-aminofuroxan-3-yl)furoxan 361
- 3,4-bis(anilino)furazan 345
- 3,4-bis(4-azidofurazan-3-yl)furazan 358
- 3,4-bis(1*H*-5-tetrazolyl)furoxan 271
- 3,4-bis(hydroxyiminomethyl)furoxan 345

- 3,4-bis(4-nitraminofurazan-3-yl)-furazan bis-hydroxylammonium salt 358
- 3,4-bis(4-nitrofurazan-3-yl)-furazan 334
- 3,4-bis(4-nitrofurazan-3-yl)-furoxan 334, 352, 361
- 3,4-bis(1,2,4-oxa-diazol-3-yl)furoxan 338
- 3,4-bis(picrylamino)furazan 345
- 3,4-bis(4-(2,2,2-trinitroethylaminofurazan-3-yl)furoxan 354
- 3,4-bis((Z)-(4-nitro-1,2,5-oxadiazol-3-yl)diazanyl)-1,2,5-oxadiazole 349
- 3,5-bis(4-aminofurazan-3-yl)-1,2,4-oxadiazole 335
- 3,5-bis-(4-amino-1,2,5-oxadiazol-3-yl)-1,2,4-triazole 359
- 3,5-bis-(4-azido-1,2,5-oxadiazol-3-yl)-1,2,4-triazole 359
- 3,5-bis(3,3-dinitrobutyl)-1,2,4-oxadiazole 334
- 3,5-bis(4-nitraminofurazan-3-yl)-1,2,4-oxadiazole 336
- 3,5-bis(4-nitrofurazan-3-yl)-1,2,4-oxadiazole 334
- 3,5-bis-(4-nitramino-1,2,5-oxadiazol-3-yl)-1,2,4-triazole 359
- 3,5-bis-(4-nitro-1,2,5-oxadiazol-3-yl)-1,2,4-triazole 359
- 3,6-bis(4-amino-1,2,5-oxadiazol-3-yl)-1,4,2,5-dioxadiazine 353
- 3,6-bis(3-azido-1,2,4-oxadiazole-5-guanyl)-1,2,4,5-tetrazine 333
- 3,6-bis(1*H*-1,2,3,4-tetrazol-5-yl-amino)-1,2,4,5-tetrazine (BTATz) 285
- 3,6-bis((4-*N*-nitro-2,2,2-trinitroethylamino)-1,2,5-oxadiazol-3-yl)-1,4,2,5-dioxadiazine 356
- 3,6-bis(3,5-dimethylpyrazol-1-yl)-1,2,4,5-tetrazine 333
- 3,6-bis(3,5-dimethylpyrazole)-1,2,4,5-tetrazine synthesis 287
- 3,6-bis(3,5-dimethylpyrazole)-1,2-dihydro-1,2,4,5-tetrazine synthesis 286, 287
- 3,6-bis(3-nitro-1,2,4-oxadiazole-5-guanyl)-1,2,4,5-tetrazine 333
- 3,6-bis(4-nitro-1,2,5-oxadiazol-3-yl)-1,4,2,5-dioxadiazine 356
- 3,6-bis(4-(2,2,2-trinitroethylamino)-1,2,5-oxadiazol-3-yl)-1,4,2,5-dioxadiazine 355
- 4,4'-bis(fluorodinitromethyl)-3,3'-azo-furazan 363
- 4,4''-bis((*N*-nitro-2,2,2-trinitroethylamino)-[3,3',4',3''-ter(1,2,5-oxadiazole)]-2'-oxide) 355
- 4,4''-bis(nitroxymethyl)-3,3',4',3''-terfurazan-2',5,5''-trioxide 359, 360
- 4,4''-bis(nitroxymethyl)-3,3',4',3''-terfurazan-2,2',2''-trioxide 359, 360
- 4,4''-bis((2,2,2-trinitroethylamino)-[3,3',4',3''-ter(1,2,5-oxadiazole)]-2'-oxide) 355
- 4,5-bis(fluorodinitromethyl)furoxan 362, 363
- 4,5-bis(1-hydroxytetrazol-5-yl)-1,2,3-triazole 270
- 4,5-bis(tetrazol-5-yl)-1,2,3-triazole 270
- 5,5'-bis(fluorodinitromethyl)-3,3'-bi-1,2,4-oxadiazole 338
- 5,5'-bistetrazole-1,1'-diolate (ABTOX) 83
- 5,5'-bis(trinitromethyl)-3,3'-bi-1,2,4-oxadiazole 338
- 5,5'-bis(2,4,6-trinitro-phenyl)-2,2'-bi(1,3,4-oxadiazole) 340
- bis(1,2,4-triazolium) 356
- bis(1,3-diazidoprop-2-yl)-glutarate 219
- bis(1,3-diazidoprop-2-yl)-malonate 219
- bis(1,5-diamino-tetra-zolium) 356
- bis(1*H*-tetrazol-5-yl)amine H₂BTA 276
- bis(2,2-dinitropropyl)-acetal (BDNPA) 207
- bis(2,2-dinitropropyl)-formal (BDNPN) 207
- bis(2,3-diazido-propoxy)diethylene glycol (BDAP) 226

- bis(3-amino-1,2,4-triazolium) 356
 bis(3,5-diamino-1,2,4-triazolium) 356
 bis(4-alkylaminofurazan-3-yl)furazans 358
 bis(4-alkylaminofurazan-3-yl)furoxans 356
 bis(aminoguanidinium) 356
 bis(carboxamideoxime) 363
 bis(chlorodinitromethyl) 363
 bis(chloroximido) 363
 bishydroxylammonium
 3,5-bis(4-nitraminofurazan-3-ylate)-1,2,4-oxadiazole 336
 bishydroxylammonium salt 356, 357
 bis(5-monomethylhydrazinyl-1*H*-tetrazolyl)alkanes 199
 bisnitramino derivative 355–357
 bis(oxalyldihydrazinium) 356
 bis(propargyl)hydroquinone (BPHQ) 192
 bis(*tert*-butyl-*NNO*-azoxy)acetonitrile 145
 bistetrazole/bridged bistetrazole-based energetic salts 269
 bis(trinitromethyl)-1,3,4-oxadiazol-2-yl)methanone 342
 black powder 239
 bond orders, of BTATz 289
 BPTA mass loss and heat flow 391
 BPTAP 383, 392
 bond length and angles of 384
 ¹³C NMR spectra 385
 crystal structure 384
 detonation performance 388
 enthalpy of formation 386
 ¹H NMR spectrum 385
 isobaric deflagration 387
 resonance structures 384
 sensitivity 391
 structure 377, 378
 synthesis 381
 thermal stability 390
 BPTAP/Kel-F-800, detonation velocity of 388
 BTATz
 bond orders 289
 DSC curve for 297
 energetic properties of 290
 geometric configuration 288
 geometric parameters 288
 physicochemical properties of 291
 synthesis 286, 287
 TG–DTG curve for 297
 unit propellant 290
 vibration and infrared spectrum 289
 vibration frequencies and intensities 290
 BTATz–CMDB propellants in DINA System
 combustion flames and quenched surface structures 320
 combustion properties 319
 preparation 296
 nonisothermal reaction kinetics 302
 preparation 296
 thermal behavior 300
 thermal decomposition reaction conditions 297
 thermal safety 306
 BTATz–CMDB propellants, plume smoke signature of 295
 BTATz–HNIW–CMDB propellants
 burning rate 322
 combustion flames and quenched surface structures 323
 formulation of 296
 kinetic calculation results 315
 thermal safety values 318
 BTATz–HNIW–CMDB propellants, in DIANP system
 nonisothermal reaction kinetics 313
 preparation 296
 thermal behavior 311, 314
 thermal decomposition reaction 311
 BTATz–NHIW–CMDB propellants 317
 BTDOs annulated with furoxan ring 154, 174
 BTDOs annulated with TDO ring 173

- BTDOs annulated with tetraazapentalene system 174
- burning rates
 of BTATz–CMDB propellants 319
 of BTATz–HNIW–CMDB propellants 322
- butadiyne 196
- 1,4-butanediol (BDO), *N*-(2-cyanoethyl)-di-ethanolamine 209
- C**
- carbon black 229, 296, 320, 322, 323
- carboxamidoxime 335, 345, 352, 361, 363
- cationic ring-opening polymerization 194, 207, 209, 232
- cellulose dinitrate acetate (CAN) 213
- ceric ammonium nitrate (CAN) 7
- chloroaniline 151
- 3-(chlorodinitromethyl)-1,2,4-oxadiazole 337
- 4-(chloromethyl)styrene 196
- click reaction 191, 231, 243
- collision-induced dissociation (CID) 6
- colored flames 398
- colored smokes 406–408, 411–413
- composite-modified double-base (CMDB) propellants 285
- continuous spectrum 397
- copper nanocomposite (Cu-Pol) 196
- Cu-HATr 110
- [Cu(1-MTZ)₆](ClO₄)₂ complex 114
- Cu(I) 5-nitrotetrazolate 363
- Cu(II) poly(5-vinyl-tetrazolate) (PVT) 196
- cyanogen azide 243, 252
- 3-cyano-4-nitrofurazan 348
- 5-cyano-2-phenyl-2*H*-tetrazole 169
- cyclo-N₅⁻*; 1
- d**
- density functional theory (DFT) 76, 111
- detonation properties, of BPTAP/Kel-F (95/5) versus PBX-9502 390
- detonative properties, of pristine BPTAP and TATB 388
- detonation properties, of γ -DBBD 388
- di(1*H*-tetrazol-5-yl)methanone oxime 276
- di-*N*-substituted tetrazines 142
- 1,1-ditetrazolylbutane (**1,1-dtb**) 121
- 1,2-di(1*H*-tetrazol-1-yl)-ethane (**1,1-dte**) 120
- 1,4-diamino-1,2,3,4-tetraoximobutane 344, 351
- 1,5-diaminotetrazole (DAT) 337, 338
- 2,2'-diamino-5,5'-bi(1,3,4-oxadiazole) 343
- 3,3'-diamino-4,4'-bifuroxan 351
- 3,4-diaminofurazan 344
- 3,5-diamino-1,2,4-triazole energetic salt 249
- 3,5-diamino-4-nitropyrazole 249
- 4,4'-diamino-3,3'-azofurazan 346
- 4,4'-diamino-3,3'-azoxyfurazan 346
- 4,4'-diamino-3,3'-bifurazan 344, 352, 353
- 4,4'-diamino-3,3'-bifuroxan 351
- 4,4'-diamino-3,3'-bifuroxan 351
- 4,8-diamino-difurazano[3,4-*b,e*]pyrazine 364
- 4,8-diaminodifurazano[3,4-*b,e*]pyrazine (DADFP) 65
- 6,8-diamino-7-nitrotetrazolo[1,5-*b*]pyridazine (TPAN) 62
- diaminoglycouril 333
- diaminoglyoxime 344, 347
- diaminoguanidine (DAG) 337, 338
- diaminoguanidinium 25, 33, 256, 263, 338
- diaminomethaniminium salt 243, 256, 260
- diammonium 83, 338, 343, 355–357, 359
- diamino-urea (DAU) 338
- dianilinoglyoxime 345
- DIANP 294
- α,α -diazidated azido ester plasticizers 221
- 1,3-diazido-2-ethyl-2-nitropropane (DAENP) 219

- 1,5-diaziido-3-nitrazapentane (DIANP) 290
- dibutyltin dilaurate (DBTDL) 208
- dichloro azo compound 142
- dichloro-oglyoxime 345
- dichlorogly-oxime 344
- 3,3'-dicyanodifurazanyl ether 273
- dicyanoglyoxime 344
- diethyl 1,3,4-oxadiazole-2,5-diacetate 341
- diethyl 1,3,4-oxadiazole-2,5-dinitroacetate 341
- diethyl 2,2'-((dinitromethylene)bis(1,3,4-oxadiazol-5,2-diyl))-bis(2,2-dinitroacetate) 341
- diethyl 2,2'-methylenebis(1,3,4-oxadiazole-5,2-diyl)-diacetate 341
- diethyl 3,3'-bis(1,2,4-oxadiazolyl)-5,5'-bis(2,2-dinitro-acetate) 338
- diethyl acetylenedicarboxylate 362
- diethyleneglycol bis(azido-acetate) (DEGBAA) 226
- difluoroamino-methyl-3-methyl oxetane (DFAMO) 218, 229
- 4H,8H-difurazano[3,4-*b,e*]pyrazine 364
- diguandinium 355, 356
- dihydrasinium salt 246, 276, 355, 357, 359
- 1,4-dihydro-1,2,3,4-tetrazine 142
- 3,4-dihydroxyfurazan 348
- 3,6-dihydrazino-1,2,4,5-tetrazine and carbonylhydrazide salts 263
- 3,6-dihydrazinyl-1,2,4,5-tetrazine 199
- diisocyanatoethane (DIE) 213
- dimethyldioxirane (DMDO) 333
- 2,2'-dinitramino-5,5'-bi(1-oxa-3,4-diazole) 343
- 3,3'-dinitramino-4,4'-azoxyfurazan 347
- 3,4-di(nitramino)furazan 347
- 3,4-dinitrofuroxan 332, 350
- 3,5-dinitro-4-chloropyrazole 251
- 4,4'-dinitro-3,3'-azo-furazan 348
- 4,4'-dinitro-3,3'-azoxy-furazan 350
- 4,4'-dinitro-3,3'-bifurazan 344
- 4,4'-dinitro-3,3'-bifuroxan 351
- 3,6-dinitro-1,4-di(1*H*-tetrazol-5-yl)-pyrazolo[4,3-*c*]pyrazole (DNTPP) 243
- 3,6-dinitropyrazolo [4,3-*c*]pyrazole (DNPP) 49, 243
- 4,4''-di-*R*-3,3',4'3''-terfuroxans 359
- 4,4-dinitropentanamidoxime 334
- 4,4-dinitropentanoyl chloride 334
- 4,4'-diphenylmethane diisocyanate (MDI) 204
- 4,5-dicyano-2*H*-1,2,3-triazole 270
- 4,6-dichloro-5 nitropyrimidine 247
- 4,8-dinitraminodifurazano[3,4-*b,e*]pyrazine 364
- 5,5'-dinitromethyl-3,3'-bis(1,2,4-oxadiazole) 338
- 5,7-dibromo-BTDO 156
- 5,7-dinitro-6,8-dibromo-BTDO 147
- 5,7-dinitro-BTDO 148
- dinitrofurazanyl ethers 348
- dinitroglyoxime 350
- 3-(dinitromethyl)-1,2,4-oxadiazole 337
- 2,4-dinitro-*N*-(prop-2-yn-1-yl)aniline 231
- O*-(4,4-dinitropentanoyl)-4,4-dinitro-pentanamidoxime 334
- 2,2-dinitropropane-1,3-diol (DNPD) 213
- dioxadiazine 353-356
- [1,4]dioxino[2,3-*c*\,5,6-*c'*]bis([1,2,5]oxadiazole) 349
- 2,5-dipicryl-1,3,4-oxadiazole 339, 340
- dipotassium
- 3,3'-bis(dinitromethyl)difurazanyl ether 363
- dipotassium
- 3,4-bis(3-dinitromethylfurazan-4-oxy)furazan 363
- dipotassium 3-dinitromethyl-4-nitraminofurazan 365
- dipotassium 4,4'-bis(dinitromethyl)-3,3'-azofurazanate 363
- dipotassium 4,8-dinitraminodifurazano [3,4-*b,e*]pyrazine 364

- dipotassium dinitraminodifurazano
[3,4-*b,e*]pyrazine 363
- ditetrazoles 116, 120, 121
- ditetrazolylpropane isomers 120
- ditetrazolylpropane (**dtP**) ligands
120
- dye 406
- e**
- energetic additives 290–294, 326
- energetic azido polycarbonates 215
- energetic coordination compounds
(ECCs) 107, 116, 122–128
- energetic copoly(ester/ether) elastomers
212
- energetic geminal dinitro polyester
230
- energetic guanidinium salt 256
- energetic mono-and
bis(vinyl-imidazolium)
perchlorates 190
- energetic poly(ionic liquid) (E-PIL)
190
- energetic salt formation 240
- energetic tetrazole ligands 116–121
- energetic thermoplastic elastomers
(ETPEs) 204, 209
- energetic thermoplastic polyurethane
elastomers (ETPUs) 208
- epichlorohydrin (ECH) 203, 207,
218
- 1,2-epoxyhexane (EpH) 207
- 1,1'-ethylenebis(5-nitroiminotetrazole)
263
- 1-ethyl-5*H*-tetrazole (**1-ETZ**) 117
- 2-ethyl-2-nitro-propane-1,3-diol 219
- 2-ethyl-2-nitropropane-1,3-diyl-
bis(4-methyl-benzenesulfonate)
219
- ethyl-2-(5-amino-2*H*-tetrazol-2-yl)acetate
257
- ethyl 2-cyanoacetate 253
- ethyl 2-(1*H*-tetrazol-5-yl)acetate 253
- 5-ethynyl-2*H*-tetrazole 196
- explosives 21, 22, 43, 47, 49, 51, 53,
58–61, 67, 74, 75, 80, 81, 83–85, 89,
93, 107–114, 129, 130, 178, 189,
198, 203, 204, 209, 212, 216, 225,
229, 230, 234, 239–242, 259, 278,
308, 309, 347, 351, 363, 364,
377–392
- extremely insensitive substance
(EIS) 76
- f**
- first-generation nitrogen-rich HEDMs
75–81
- fluorodinitroacetaldoxime 363
- FOX-7-based compounds 247
- Frank–Kamenetskii (FK) parameter 310
- free acid 5-nitrotetrazole-2*N*-oxide 268
- fuel mixes 406, 407
- fully unsaturated 1,2,3,4-tetrazines
annulated 1,2,3,4-tetrazines 142
benzoannulated TDOs 147
heteroannulated 1,2,3,4-tetrazine
1,3-dioxides 158
nonannulated 1,2,3,4-tetrazine
1,3-dioxides 145
nonannulated 1,2,3,4-tetrazine 1-oxides
and benzotetrazine 1-oxides
(BTOs) 143
- functionalized
pyrazolo-benzotetrazin-3-ones
141
- furazan 248, 344
- furazan-functionalized
nitramino-tetrazole compound
263
- furazano-annulated TDO 141
- furazano-tetrazine 4,6-dioxide (FTDO)
158
- 3(4)-*R*-furoxan-(3)4-carbaldehyde 361
- 3(4)-*R*-furoxan-(3)4-nitrocarboxime 361
- (4)-*R*-furoxan-(3)4-carboxime 361
- 4-*R*-(furoxano-2)-3-carboximidoyl
chlorides 352
- furoxan-fused 1,2-diazocine 361
- furoxans 344

- fused-ring aromatic energetic compounds
 [5,5]-bicyclic-backbone-based energetic
 compounds 49
 multi-cyclic energetic compounds 63
- g**
- GAP-*b*-PAEMA 202
 GAP/poly(caprolactone) (PCL) 208
 gem-dinitro REPs 232
 glycidyl azide (GA) 203
 glycidyl azide fluorine-containing
 polymer (FGAP) 218
 glycidyl nitramine 232
 glycidyl nitrotriazolone polymers 194
 glycidyl triazolone 194
 glycidyl triazolone-GAP copolymers
 194
 green energetic materials 240
 guanidinium 5,5'-azotetrazolate 409,
 413
 guanidinium bicarbonate (Gu)
 337, 338
 guanidinium bis(3-nitro-1,2,4-oxadiazole-
 5-yl)-amine 337
 5-guanidino-3-nitro-1,2,4-oxadiazole
 333
 GZT-based colored smoke formulations
 411
- h**
- halogen precursor copolymer
 epichlorohydrin/3,3-
 bis(bromomethyl-oxetane)
 (ECH/BBrMO) 203
 heat of formations (HOFs) 1, 5,
 21, 40–43, 52, 63, 64, 81, 86,
 168, 169, 177, 178, 221, 240,
 361, 409
 heat resistance 169–172, 174, 310
 hetaryl tetrazoles 245
 heteroannulated 1,2,3,4-tetrazine
 1,3-dioxides
 annulation with the 1,2,3-triazole ring
 158
 annulation with the pyridine ring 162
 with furazan ring 158
 tetrazino-tetrazine tetroxide (TTTO)
 162
 heterocyclic compounds 240, 241, 248,
 257, 263
 heterocyclic energetic polymers and
 plasticizers 189–200
 3-heterocyclic-4-nitrofuraxans 362
 heterocyclic *N*-oxides 139
 heterocyclic polymers 191, 194, 234
 hexamethylene diisocyanate 211, 213
 hexanitrohexaazaisowurtzitane (HNIW)
 286, 290
 hexogen (RDX) 290
 Hg(II) perchlorate polymeric complex
 (HMPT) 109
 1*H*,1'*H*-5,5'-bitetrazole-1,1'-diolate (BTO)
 268
 high-energy density materials (HEDMs)
 65, 73, 239
 high-nitrogen salts 336, 337, 347, 402
 5,5'-(hydrazonomethylene)bis(1*H*-
 tetrazole) 276
 hydrazine 197, 241, 257, 259, 267, 278,
 337, 356, 358
 hydrazine monohydrate 257
 hydrazinium 25, 33, 40, 80, 192, 243,
 245, 246, 248, 252, 259, 263, 269,
 272, 342, 347, 355
 hydrazinium nitroformate (HNF) 192
 5-hydrazinotetrazole 265
 hydroquinone-linked bis(triazole-azide)
 copolymer 192
 hydroxylammonium 25, 33, 40, 56, 243,
 245, 246, 248–253, 256, 258, 259,
 263, 267, 269, 270, 337, 342, 347,
 355
 hydroxylamine-*O*-sulfonic acid 364
 3-hydroxy-4-nitrofurazan 348
 hydroxy-telechelic PGT pre-polymer
 232
 hydroxy-telechelic poly(glycidylazide-*co*-
 tetrahydrofuran) (PGT)-based
 energetic polyurethane (PU)
 binders 232

- hydroxyl-terminated poly(butadiene) (HTPB) 192
- hyperbranched poly(3-azidomethyl-3-hydroxymethyloxetane) (HBPAMHMO) polymers 208
- hyperbranched poly(3-ethyl-3-[hydroxymethyl]oxetane) core (PEHO-c) 208
- hyperbranched poly(TMPO)-co-poly(THF) copolymers 194
- i**
- ICM-103 60
- illuminants 397, 399, 400
- imidazolium-based poly(ionic liquids) 190, 234
- incandescence 397
- in-line-detonators 108
- intermediate dinitro-bis(5-(trinitro-methyl)-1,3,4-oxadiazol-2-yl) methane 342
- intermediate 1-methoxy-5-aminotetrazole 259
- intermediate 1,2,4-oxadiazole-3-azidoxime 337
- ionic *N*-oxide compounds 256
- isobaric BPTAP combustion in air 387
- isobaric BPTAP deflagration 387
- isomeric 5-azido-7-bromo-BTDO 156
- l**
- La(acetylacetonate)₃ 215
- laser ignition system 112–116
- laser initiation 107–114, 120, 128–131
- light-generating pyrotechnics 397–405
- line spectrum 397
- linear poly(glycidylazide)-based shell (GAP-s) 208–209
- luminescence 397
- m**
- M126A1 red star parachute hand-held signal 399
- M195 green-light emitting HHS parachute 400, 402
- machine learning (ML) algorithms 74, 97
- m-chloroperbenzoic acid (MCPBA) 7, 87, 145, 363
- 1-methoxy-5-aminotetrazole 259, 260
- 1-methyl-3,5-bis-(4-nitramino-1,2,5-oxadiazol-3-yl)-1,2,4-triazole 359
- 1,1-methyltetrazolylhydrazine containing polymers 199
- 2-methyl-4,5-dicyano-1,2,3-triazole 243
- 2-methyl-5-amino-1,3,4-oxadiazole 339
- 2-methyl-5*H*-tetrazole (**2-MTZ**) 117
- 2-methyl-5-nitro-1,3,4-oxadiazole 339
- methyl-2-(5-amino-1*H*-tetrazol-1-yl) acetate 257
- methylated polyazole energetic compounds 243
- methylenebistetrazole 249
- methyl 3-nitro-1,2,4-carboxyl-5-ate 332
- N*-methyl-*N*-nitroso-*N'*-nitroguanidine 257
- monoanionic salts 276
- monopropellants, energy characteristics for 291
- mono-tetrazole ligands 116, 119
- 1-MTZ 116
- n**
- nano iron oxide 192
- neutral energetic compound 247
- next generation pyrotechnics 407
- NH₄Cl (or gaseous NH₃) 337
- [(NH₂TriTzPyr)₃Fe][ClO₄]₂ complexes 111
- 3-(4-nitraminofurazan-3-yl)-1,2,4-oxadiazole-5-nitramine 336
- 3-(4-nitraminofurazan-3-yl)-4-(4-nitrofurazan-3-yl)furazan 358
- 5-nitramino-3-nitro-1,2,4-oxadiazole 333
- nitramino tetrazole containing compound 259
- nitraminotetrazole energetic compounds 257, 258, 262
- nitration, of tetraazapentalenes 382

- 2-nitro-2-azapropyl chloride 253
- 3-R-4-nitrofurazans 348
- 2,2'-((nitromethaneidyl)bis(1,3,4-oxadiazol-5,2-diyl))-bis(2,2-dinitromethanide) 342
- 2-(4-nitro-1,2,5-oxadiazol-3-yl)-5-amino-1,3,4-oxa-diazole 343
- 3-(4-nitrofurazan-3-yl)-1,2,4-oxadiazole-5-amine 335
- 3-(4-nitro-furazan-3-yl)-1,2,4-oxadiazole-5-nitramine 336
- 3-nitramino-4-(5-amino-1,3,4-oxadiazol-2-yl)-furazan 342, 343
- 3-nitrato-methyl-3-methyloxetane (NIMMO) 228
- 3-nitro-1,2,4-triazole-5-one (NTO) 75
- 3-nitro-1-(2*H*-tetrazol-5-yl)-1*H*-1,2,4-triazol-5-amine (HANTT) 252
- 3-nitro-1*H*-1,2,4-triazol-5-amine 252
- 3-nitro-4-(4-R-furoxan-3-yl)furoxans 352, 353
- 3-nitro-4-(4-nitrofurazan-3-yl)furoxan 352
- 3-nitro-4-(picrylamino)furazan 345
- 3-nitro-4-hydroxyfurazan 348
- 3-nitro-5-amino-1,2,4-oxadiazole 336
- 3-nitro-5-trichloromethyl-1,2,4-oxadiazole 332
- 3-nitrofurazanyl ether 348
- 3-nitroheterocycles 332, 362
- 4-nitro-3-(1*H*-tetrazol-5-yl)furoxan (HTNF) 254
- 4-nitro-3-(4-nitrofurazan-3-yl)-furoxan 352
- 4-nitro-3-(chlorodinitromethyl)furazan 355
- 4-nitro-3-(dinitromethyl)-furazan 354
- 4-nitro-7-azido-pyrazol-[3,4-*d*]-1,2,3-triazine-2-oxide (NAPTO) 61
- 4-nitro-furoxanylcarbonitrile oxide 362
- 4-nitrofurazan-2-*ONN*-azoxyazidofurazan 350
- 4-nitrofurazan-3-(dinitromethylide) 355
- 4-nitrofuroxannitrolic acid 362
- (*E*)-4-((4-nitro-1,2,5-oxadiazol-3-yl)diazenyl)-1,2,5-oxadiazol-3-amine 349
- (*E*)-4-((4-nitro-1,2,5-oxadiazol-3-yl)diazenyl)-1,2,5-oxadiazol-3-ol 349
- 5-(4-nitro-(1,2,5)oxadiazolyl]-5*H*-[1,2,3]triazolo[4,5-*c*][1,2,5]oxadiazole 349
- 5-nitrotetrazole 108
- 5-nitro-6-azido-BTDO 155
- 6-nitro-7-azido-pyrazol[3,4-*d*][1,2,3]triazine-2-oxide (ICM-103) 58
- nitrocellulose-derived polymers 213
- nitrogen rich tetrazine energetic compounds 287
- nitrogen-rich ammonium 266
- nitrogen-rich energetic compounds 285
- nitrogen-rich energetic polymers lacking traditional explosives groups 201–202
- nitrogen-rich HEDMs
 first-generation 75–81
 second-generation 81–84
 third-generation 84–85
 works 74–75
- nitrogen-rich heterocyclic compounds 241, 248, 263
- nitroglycerine 209, 239
- nitro group containing polymers 225–230
- nitro-hydroxyl terminated poly(butadiene) (NHTPB) polymer 230
- nitroimino-tetrazole compound 1,1'-ethylenebis(oxy)bis(5-nitroiminotetrazole) 263
- nitroiminotetrazole derivatives 260
- nitromethane-bridged bis(1,3,4-oxadiazoles) 342
- nitro, nitramino, or azido tetrazole energetic salts 242
- nitro-1,2,3-triazolate anion 194
- (nitro-*NNO*-azoxy)benzene 172
- nitro-substituted 1,2,4-oxadiazoles 332

- nitro-substituted 1,3,4-oxadiazole 339
 nitrotetrazolate-2*N*-oxide salts 268
 nitro tetrazole compound 246, 254
 nitrotetrazoles 244, 250, 254, 255
N,N'-bis(2,4,6-trinitrobenzoyl)hydrazine 340
N-(3,5-dinitro-1*H*-pyrazol-4-yl)-1*H*-tetrazol-5-amine (TNP) 251
N-aryl substituted tetrazines 141
N-butyl-*N*-(2-nitroxyethyl)nitramine (Bu-NENA) 207
N-methoxycarbonyl-1,5-diaminotetrazole 259
N-nitroimines 145
 non-annulated 1,2,3,4-tetrazine
 1,3-dioxides (TDOs) 171–172
 from aliphatic precursors 145–146
 benzotetrazine 1,3-dioxides 147
 non-annulated 1,2,3,4-tetrazine 1-oxides and benzotetrazine 1-oxides (BTOs) 143
 nonisothermal reaction kinetics
 BTATz-CMDB propellants, in DINA system 302
 BTATz-HNIW-CMDB propellants, in DIANP system 313
 NTO/5,6,7,8-tetrahydro-tetrazolo[1,5-*b*][1,2,4]-triazine (TZTN) 76
- O**
ortho-nitrosoazides 143
 oxadiazoles 159, 331–367
 5-(1,2,4-oxadiazole-3-yl)-1-hydroxytetrazole 337
 1,2,4-oxadiazole-3-chloroxime 337, 338
 1,2,4-oxadiazole 331, 332
 1,2,4-oxadiazole ring system 335
 1,2,5-oxadiazole 344
 1,2,5-oxadiazole (furazans) 331
 1,2,5-oxadiazole-2-oxides 331, 344
 1,2,5-oxadiazole ring conjugated with tetrazole 273
 1,3,4-oxadiazoles 331, 339
 oxepino[2,3-*c*,4,5-*c'*,6,7-*c''*]tris[1,2,5-oxadiazole 358
 oxodiazonium ion 144, 145
 4,4'-oxybis[3,3'-(1*H*-5-tetrazol)]furazan (H₂BTFOF) 273
 oxygen balance (OB) 52, 68, 74, 178, 212, 240–243, 245, 247, 249, 253, 254, 256, 260, 263, 265–267, 276, 279, 285, 290, 331, 342, 361, 365, 386
- P**
 P(GA-co-1,2-EpH) copolymer 207
 p-(GTO-co-GA) azide co-polymers 196
 PBAMO/GAP random block ETPE 211
p-dimethylaminophenylpentazole (DMAP-N₅) 2
 pendant bis(azidoacetyloxymethyl) (PNBAA) 215
 pentaamine-(5-cyano-1*H*-tetrazole)Co(III) perchlorate (**CP**) 107
 pentaamine-(5-nitro-1*H*-tetrazole)Co(III) perchlorate (**NCP**) 108
 pentalene, synthesis 381
 pentazole
 cyclo-N₅
 ArN₅ 6, 7
 density 40
 heat of formation and detonation performance 40–42
 IR spectra 38
 [3+2] reaction of N₃⁻ and N₂ at high pressure 8
 ¹⁵N NMR spectrum 37–38
 sensitivity 40
 single-crystal X-ray structures 26–37
 synthesis 25–26
 thermal stability 38–40
 metal and *cyclo*-N₅⁻ complexes
 bonding study 18–21
 coordination polymers 12–14
 detonation properties 21–24
 metal–inorganic frameworks (MIFs) 10–12
 metal salts of *cyclo*-N₅⁻(OD) 9, 11
 MS and NMR characterization 14
 Raman and IR analysis 15, 16

- thermal stability 16–18
- topology analysis 14–15
- substituted
 - arylpentazoles (ArN₅) 2
 - BzN₅ 3, 45
 - CH₃, –CN, and –NH₂ 3
 - heterocycle 3
 - polypentazoles clusters 4
- perchlorate-free hand-held signal illuminants
 - for M126A1 red star parachute hand-held signal 399
 - for M195 green star parachute 400
- perchlorates oxidizer 397
- PGN triblock copolymer poly(glycidyl nitrate-block-poly(butadiene)-block-glycidyl nitrate) (PGN-PB-PGN) 225
- phenyl-bis(2,4,6-trimethylbenzoyl) phosphine oxide 190
- 2-phenyl-2*H*-1,2,3-triazole 169
- 1-phenyl-*N*-(1*H*-tetrazol-1-yl) methanimine 264
- phenylpentazoles (PhN₅) 2, 7
- picrylamino-substituted oxadiazoles 344
- picrylamino-substituted-1,2,4-oxadiazoles 345
- picryl-substituted 1,3,4-oxadiazoles 339
- plastic-bonded explosives (PBXs) 232
- poly(1-(3-nitrophenyl)-1*H*-1,2,3-triazol-4-yl) acrylate 192
- poly(1-(3-nitrophenyl)-1*H*-1,2,3-triazol-4-yl) acrylate 192
- poly(2,2'-bisazidomethyl-1,3-propylcarbonate) poly(BAMPC) 215
- poly(3-[2-(nitro-oxylethyl)-1-vinylimidazolium bromide] 190
- poly(3-azido-1,2-propylcarbonate) 215
- poly(3-difluoroaminomethyl-3-methyloxetane-3-nitrato-methyl-3-methyl-oxetane) (PDN) copolymer 229, 230
- poly(3,3-bis(azidomethyl)-oxetane) (PBAMO) 211
- poly(3,3-bis(2,2,2-trifluoroethoxy-methyl)-oxetane)-glycol-block-poly(3-nitratomethyl-3-methyloxetane) (PBFMO-*b*-PNMMO) 228
- poly([*p*-(azidomethyl)styrene]-*co*-(5-vinyltetrazole)) (PAST) 196
- poly([*p*-(chloro-methyl)-styrene]-*co*-acrylonitrile) (PCSA) 196
- poly(azidoaminoethers) 212
- poly(bis(azidomethyl)oxetane) (poly(BAMO)) 199
- poly(epichlorohydrin) (PECH) 212
- poly(glycidylazide-*b*-poly(azidoethylmethacrylate)) (GAP-*b*-PAEMA) 202
- poly(glycidylazide-*r*-3-azido-tetrahydrofuran) (PGAAT) 213, 214
- poly(glycidyl nitramine) 232
- poly(glycidyl nitrate) (PGN) 190, 199, 201, 225, 227, 228
- poly(hexamethylene(2,2-bis(azidomethyl)propylene)carbamate) (HMDI-BAMP) 214
- poly(hexamethylene(2,2-dinitropropylene)carbamate) (HMDI-DNPD) 214
- poly(lactic-acid)-block-poly(glycidylazide)-block-polystyrene (PLA-*b*-GAP-*b*-PS) 204
- poly(NIMMO)-(HTPE)-poly(NIMMO) 228
- poly(nitramidotetrazoles) 197, 198
- poly(nitro butadiene) (NPB) 230
- poly(triazole-polyethylene-oxide-tetrahydro-furan) (PTPET) 191, 207
- poly(vinyl-azido-acetate) (PVAA) energetic polymer 211, 212
- poly(vinyl chloride) 194
- poly(vinyl-imidazolium chloride) 190
- poly(vinyl-imidazolium nitrate) 190
- poly(vinyl nitrate) (PVN) 227

- poly(vinyl-*p*-nitrobenzal-acetal)-*g*-poly(glycidylazides) (PVPNB-*g*-GAPs) 203
- poly(vinyl-tetrazole) 194, 197
- poly(vinyl-trinitro-nitro-benzal acetal) (PVPNB) 231
- polyazido-substituted BTDOs 147
- polychlorinated dibenzofurans (PCDF) 408
- polychlorinated dibenzo-*p*-dioxins (PCDD) 408
- polyether polyurethane azide elastomers 204
- polynitrogen material
- all-nitrogen cluster N₄ 93
 - all-nitrogen cluster N₆ 93, 94
 - all-nitrogen crystals composed of N₈ 94
 - all-nitrogen crystals composed of N₁₀ 95
 - all-nitrogen HEDMs with cubic Gauche structure 96
 - ambient conditions 85
 - of cyclo-N₅⁻
 - ambient and high pressures 87
 - dual-aromatic 91
 - in (N₅)₆(H₃O)₃(NH₄)₄Cl 90
 - pentazole Compounds with Non-nitrogen Stabilizer 88
 - N₃⁺ 85
 - N₅⁺ 86
- poly-3-nitratomethyl-3-methyloxetane (polyNIMMO or PLN) 219
- polynitrotetrazole compounds 253
- polypentazoles clusters 4
- polyvinyl chloride (PVC) 397, 399, 400
- potassium 1,1-dinitramino-5,5'-bistetrazolate 363
- potassium 1,2,4-oxadiazole-3-dinitromethylide 337
- potassium 3-dinitromethyl-4-nitraminofurazan 363–365
- potassium 4,5-bis(dinitromethyl)furoxanate 363
- potassium 6-nitro-5-oxidopyrazolo [3,4-*c*][1,2,5]oxadiazol-4-ide 363, 365
- potassium chlorate oxidizer 405
- propellants
- energetic properties of 291–295
 - energy characteristic parameters of 292–294
 - exothermic decomposition processes of 301
 - plume smoke signature of 295
 - preparation of 296
 - specific formulations 292
- PVPNB-*g*-GAPs 203
- pyrazoles 65, 177, 240, 241, 248, 331
- pyrido-annulated TDOs 141
- r**
- RB0601 propellants
- adiabatic time-to-explosion 307
 - characteristic drop height of impact sensitivity 308
 - critical temperature of hot–spot initiation 308
 - critical temperatures of thermal explosion 306
 - critical thermal explosion ambient temperature 310
 - exothermic decomposition 302, 303, 307
 - mechanism functions, apparent activation energies and kinetic equations 305
- PDSC characteristic values and burning rates 324, 325
- safety degree 310
- self-accelerating decomposition temperature 306
- thermal explosion probability 310
- thermal ignition temperature 306
- thermal sensitivity probability density function 310
- thermodynamic parameters, of activation reaction 307

- RB0602 propellants
 adiabatic time-to-explosion 307
 characteristic drop height of impact sensitivity 308
 critical temperature of hot-spot initiation 308
 critical temperatures of thermal explosion 306
 critical thermal explosion ambient temperature 310
 exothermic decomposition 302, 304, 307
 mechanism functions, apparent activation energies and kinetic equations 305
 PDSC characteristic values and burning rates 324, 325
 safety degree 310
 self-accelerating decomposition temperature 306
 thermal explosion probability 310
 thermal ignition temperature 306
 thermal sensitivity probability density function 310
 thermodynamic parameters, of activation reaction 307
- RDX/BTATz-CMDB propellants, formulation of 296
- reactive energetic plasticizers (REPs) 232
- S**
- sebacoyl chloride 212
- second-generation nitrogen-rich HEDMs 81
- silver 1-methoxy-5-nitroiminotetrazolate 260
- small-scale high-nitrogen M195 formulations 402
- small-scale reactivity tests (SSRTs) 113
- smoke dye 405
- smoke formulations 405–411
- smoke, white 411
- sodium 1,3-bis(3-nitro-1,2,4-oxadiazole-5-yl)triaz-2-ene 337
- sodium bis(3-nitro-1,2,4-oxadiazole-5-yl)amine 336, 337
- sodium bis(3-nitro-1,2,4-oxadiazole-5-yl)triaz-2-ene-1-ide 336
- Staudinger-reduced GAP precursor 232
- 1-substituted 5*H*-tetrazoles 116
- 7-*R*-substituted
 7*H*-tris[1,2,5]oxadiazolo[3,4-*b*\,3',4'-*d*\,3'',4''-*f*]azepines 358
- sugar-free multi-colored smoke formulations 406
- symmetrical difurazanyl ethers 348
- synthesis energetic coordination complexes
 1-AET ligand 122
 1,1-ditetrazolylalkanes 123
 1-ETZ ligand 121
 1-MTZ ligand 121
 1-NET ligand 122
 energetic properties of ligands 122, 127
 molecular structures 122, 123, 134
 UV-vis spectroscopy of 128
- t**
- TATB 47
 crystal structure of 48
 layer structure 48
 molecular structure of 48
- TDO annulated with 6-membered heterocycle 175
- TDO annulated with tetraazapentalene ring systems 141, 175
- TEGDN 294
- tert*-butyl hypochlorite 142
- (*tert*-butyl-*NNO*-azoxy)acetonitrile 158
- tetraamine-*cis*-bis(5-nitro-1*H*-tetrazole) Co(III) perchlorate (**BNCP**) 107
- tetraazapentalene ring systems 141
- tetraazapentalenes 162
 nitration of 382, 383
 thermal stability 391
- tetraazapentalenes synthesis
 annulated with tetrazine 1,3-dioxide ring 383

- tetraazapentalenes synthesis (*contd.*)
 bearing *tert*-butylazoxy group 383
- 1,3a,6,6a-tetraazapentalene structure
 377, 378
- tetra-azido energetic plasticizers 219
- tetra-azido ether energetic plasticizer
 1,2,8,9-tetraazido-4,6-dioxol-
 nonane (TADONA) 224
- tetraethylammonium fluoride (TEAF)
 216
- tetrahydro-tetrazines 139
- 1,3,5,7-tetranitro-1,3,5,7-tetrazocine
 (HMX) 239
- 2,3,5,6-tetranitro-4*H*,9*H*-dipyrazolo[1,5-
 a\,5',1'-d][1,3,5]triazine (PTAN)
 64
- tetrazine 248
- tetrazine-based energetic polymers 199
- tetrazine-1,3-dioxides (TDOs) annulated
 with 5-membered heterocycles
 175
- 1,2,3,4-tetrazine 1,3-dioxide cycle
 (TDO-cycle) 144
- 1,2,3,4-tetrazine 1,3-dioxides (TDOs)
 141
- 1,2,3,4-tetrazines
 applications 177
 with bridgehead nitrogen atoms 142
 with carbon substituents at nitrogen
 atoms 141
 fully unsaturated 142
 NMR and X-ray studies 164
 thermal stability 168
- 2,3,4-tetrazines with two bridgehead
 nitrogen atoms 177
- tetrazino-benzotetrazine tetraoxide
 (TBTTO) 151
- [1,2,3,4]tetrazino[5,6-e][1,2,3,4]tetrazine-
 1,3,6,8-tetraoxide (TTTO) 63
- tetrazino-tetrazine 1,3,6,8-tetraoxide
 141
- tetrazino-tetrazine tetroxide (TTTO)
 162
- 1-(2-(2*H*-tetrazol-2-yl)ethyl)-1*H*-tetrazole
 (**1,2-dte**) ligand 120
- 2-(1*H*-tetrazol-1-yl)ethan-1-ol (**1-HET**)
 118
- 2-(1*H*-tetrazol-1-yl)ethyl nitrate (**1-NET**)
 118
- 2-(2*H*-tetrazol-1-yl)ethan-1-ol (**2-HET**)
 118
- tetrazole-acetate-functionalized
 nitrocellulose derivatives 198
- tetrazole-based nitrogenous salts
 amino/hydrazine-tetrazole energetic
 salts 263
 bistetrazole/bridged bistetrazole-based
 energetic salts 269
 nitro, nitramino, or azido tetrazole
 energetic salts 242
- tetrazole *N*-oxide energetic salts 266
- tetrazole *N*-oxide nitrogenous salts 279
- tetrazole *N*-oxide energetic salts 266
- tetrazolyl-ethyl cellulose ether 198
- thermal safety 286, 297–318, 326, 327
- thermochemistry, of BPTAP 386
- [NH₄]₃N₃ 85
- time-dependent density functional theory
 (TDDFT) 87
- triaminoguanidine (TAG) 201, 286, 326,
 337, 338
- triaminoguanidinium azotetrazolate
 (TAGzT) 80
- triaminoguanidinium salt 256, 263
- 2,4,6-triamino-1,3,5-trinitrobenzene
 (TATB) 239
- 3,4,5-triamino-1,2,4-triazole 252
- 1,3,5-triazine-functionalized hydroxyl
 terminated poly-(butadienes)
 (HTPBs) 199
- 5-(1,2,4-triazol-3-yl)tetrazol-1-oles 256
- 5-(1,2,4-triazol-3-yl)tetrazoles 256
- 1,1,1-trifluoro-2,3-epoxypropane 218
- 2,4,6-trinitrobenzoyl chloride 340
- (2,4,6-trinitrobenzoyl)oxalohydrazide
 340
- 2,4,6-trinitro-*N*-(prop-2-yn-1-yl)-aniline
 231
- 2,4,6-trinitrotoluene (TNT) 239
- triazol-1-yl-substituted isomer 153

- 1,2,3-triazolo-annulated TDOs 141
 triazolofurazan 158
 triazolo-triazine building block 245
 triethyleneglycol dinitrate (TEGDN)
 290
 trifluoroacetic acid anhydride (TFAA)
 243
 trifluoroacetic anhydride (TFAA) 337,
 344
 2,2,2-trifluoro-ethoxymethyl-epoxy-*r*-
 glycidyl azide copolymer
 poly(TFEE-*r*-GA) 216
 trifurazan derivative 348
 tri(hydrazinium) 342
 trimethylsilyl azide (TMS-N₃) 216
 5-(trinitromethyl)-2*H*-tetrazole 246
 1,3,5-trinitro-1,3,5-triazine (RDX)
 239
 7*H*-tris[1,2,5]oxadiazolo[3,4-*b*\,3',4'-
d\,3'',4''-*f*]azepine 358
 tris(hydroxylammonium) 342
 [2,3-*c*4,5-*c'*\,6,7-*c''*]tris[1,2,5-oxadiazole-
 1-oxide 356
 tritosyl derivative 199
 [(TriTzPyr)₃Fe][ClO₄]₂ 111
- u**
 ultra-fine ammonium perchlorate (UFAP)
 285
 unsaturated tetrazine 1-oxides 141
- urethane reaction of functional
 pre-polymers mono-functionalized
 poly(3,3-bis-azidomethyloxetane)
 (UPBAMO) 209
- v**
 1-vinyl-imidazole 189, 190
 vinyl-imidazolium perchlorate monomers
 190, 191
 vinyl-tetrazole 196, 197
 VOERE company 113
 VS2 formulation 110
- w**
 white Ba(HBTA)₂·4H₂O salt 276
 white smoke 408–412
- y**
 y-DBBD, synthesis 381
 y-TACOT
 structure 377–383
 synthesis 378, 379
- z**
 z-TACOT
 reactivity of nitro groups in 379, 381
 with sodium methoxide and aminating
 reagents, interaction of 382
 structure 377
 synthesis 377, 378

