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INDIAN HEAD

TriazoloAminoTriazinylTetrazine (TATTz) Salts: Insensitive Propellant Ingredients

**2006 Insensitive Munitions & Energetic Materials
Technology Symposium**

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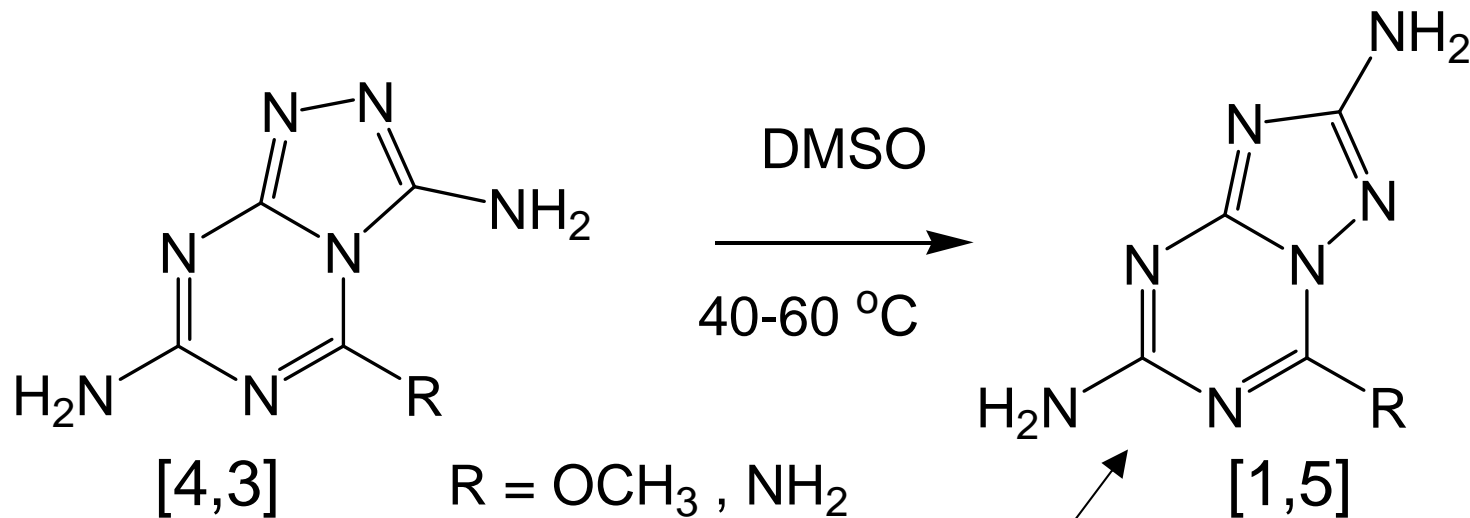
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Indian Head Division**

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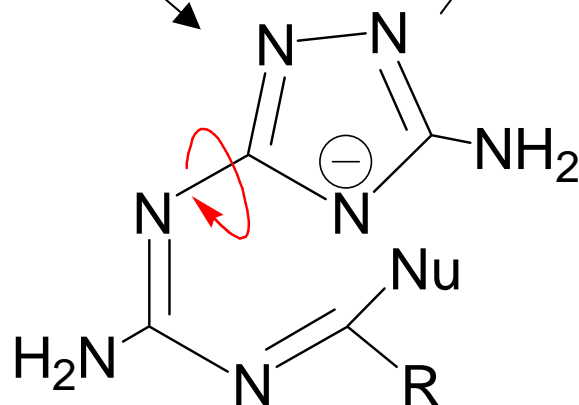


Triazolotriazines

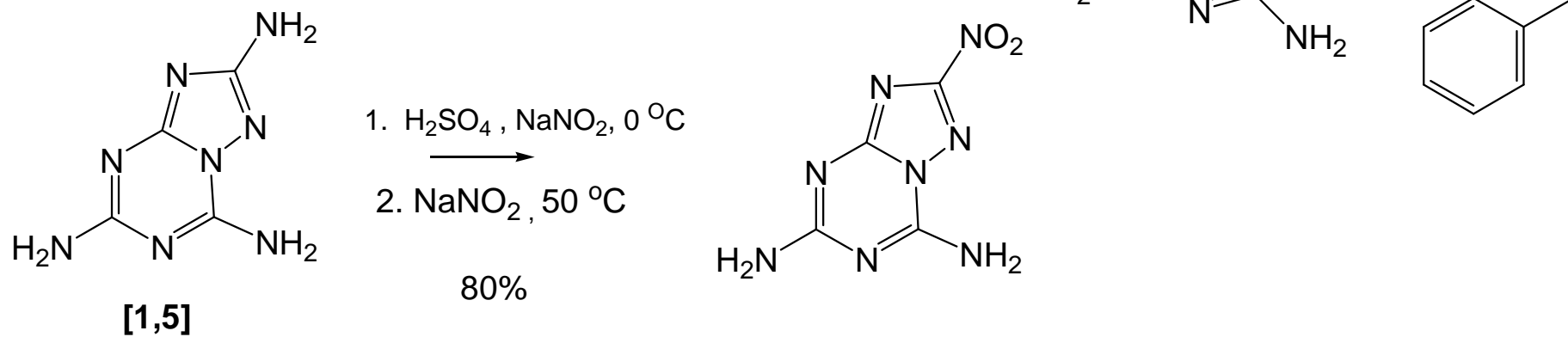
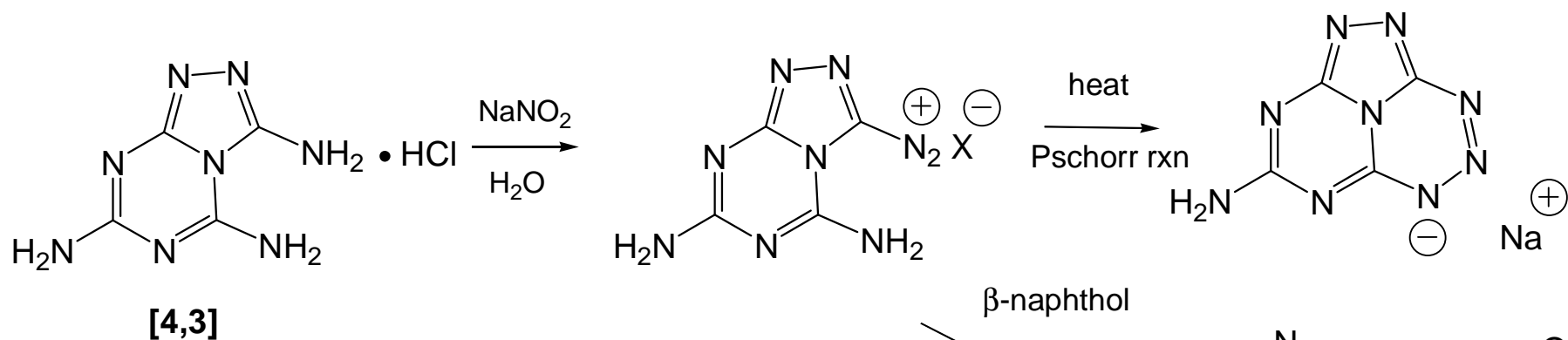
Rearrangement to Lower Energy



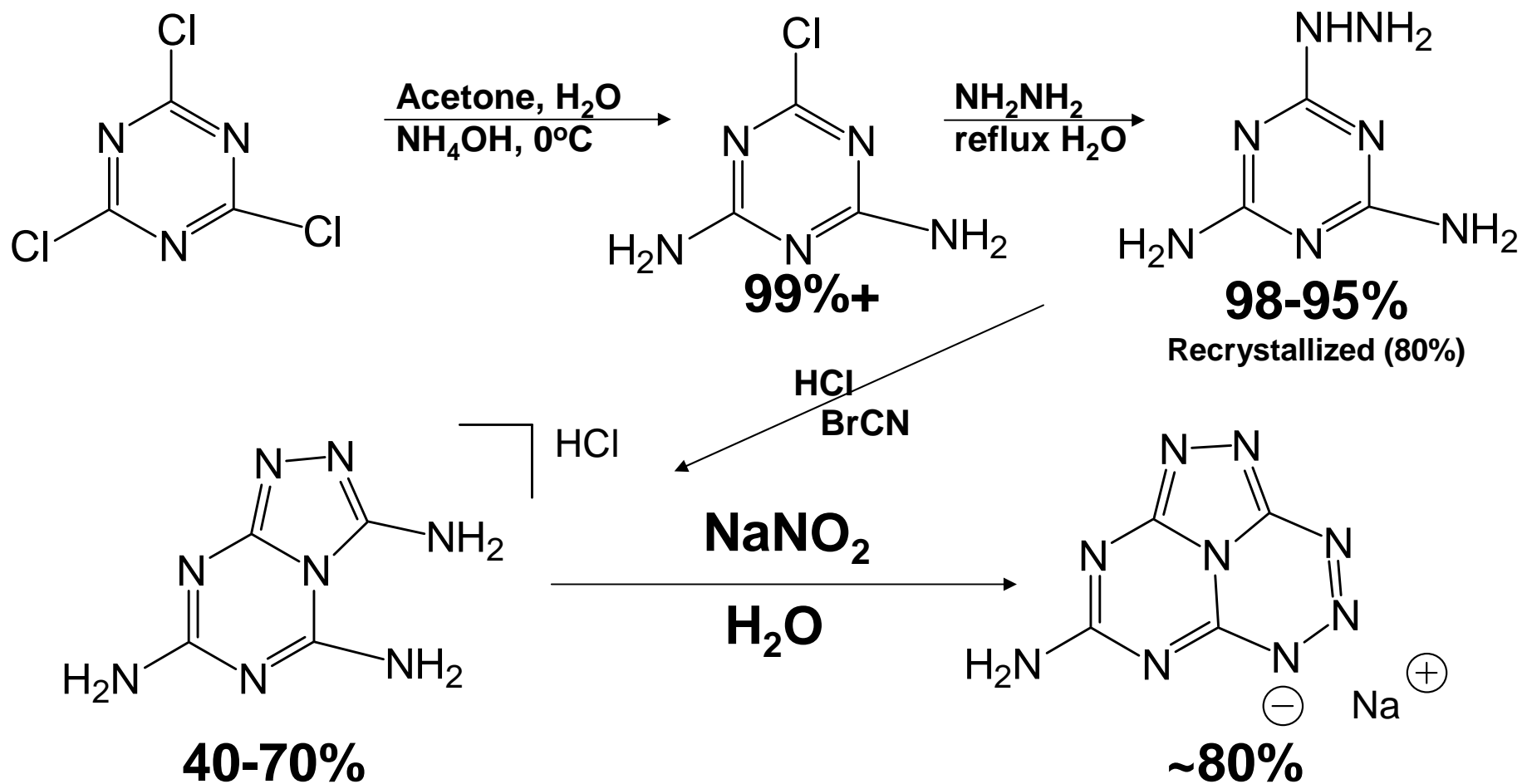
triazole amine twisted out of the plane of the ring system



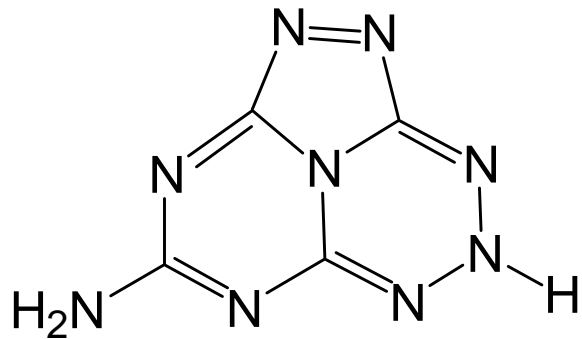
Diazonium Reactions



1,2,3,5-Tetrazine Synthesis



TATTz Properties



Density 1.77g/cm³

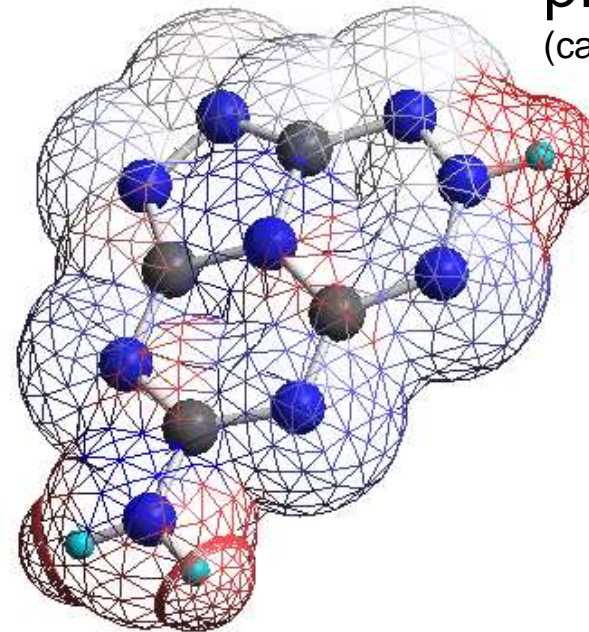
DSC = 213 °C

Impact H₅₀ = 17cm

Friction = <30 psig

ESD = .008J

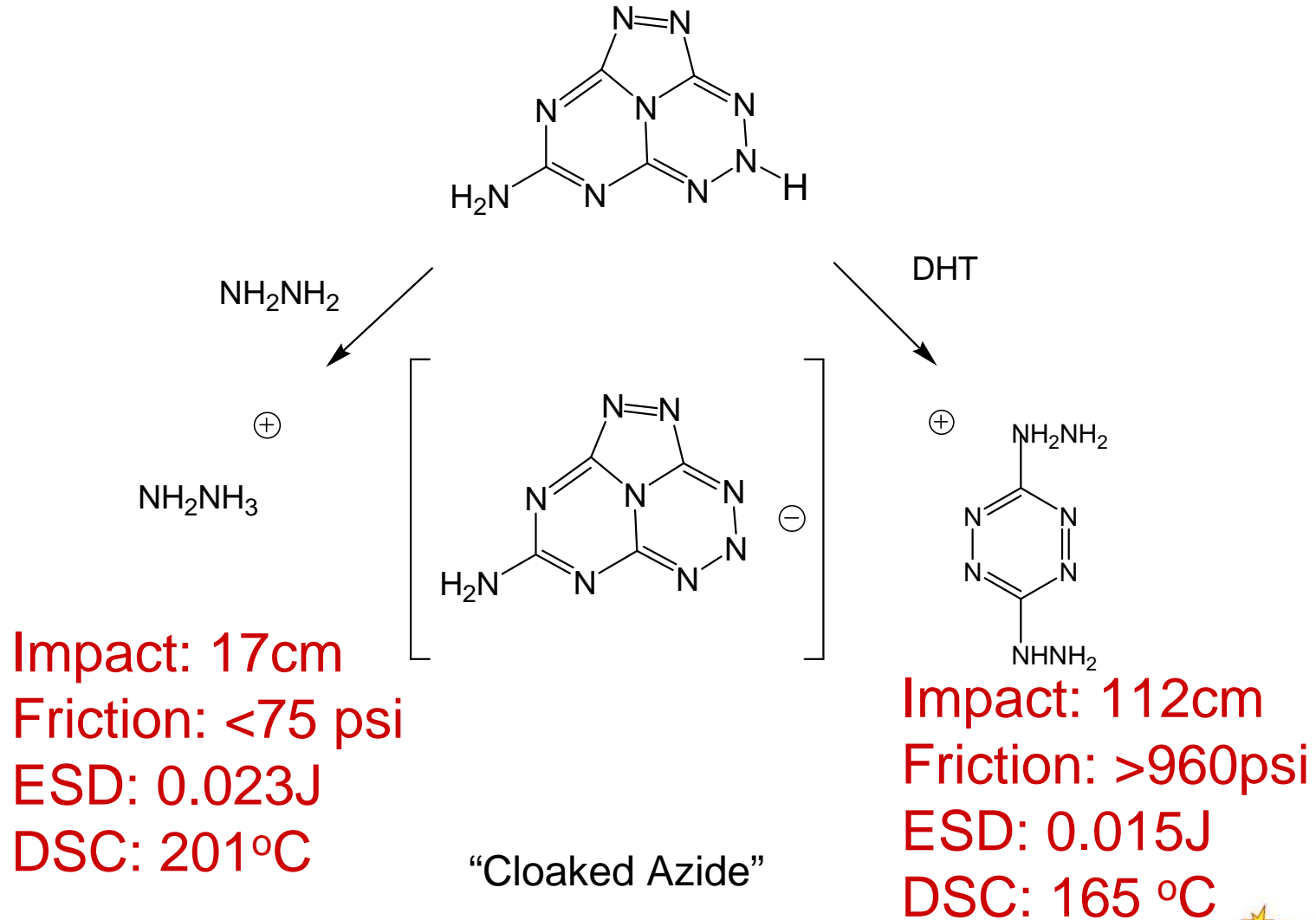
(lower limit of test apparatus)



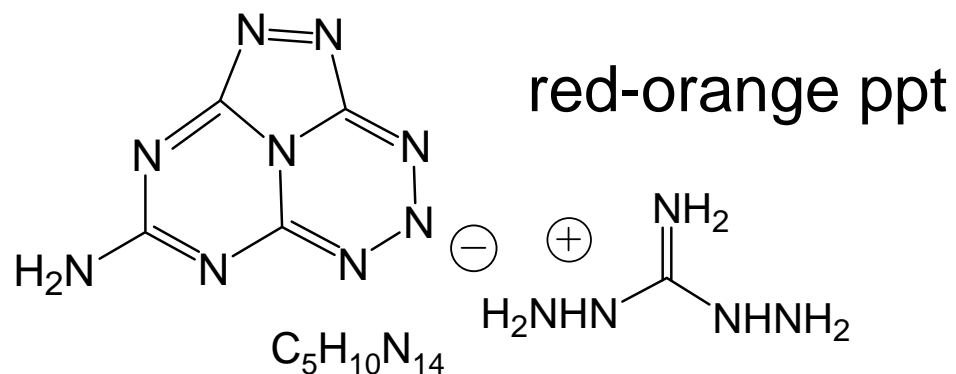
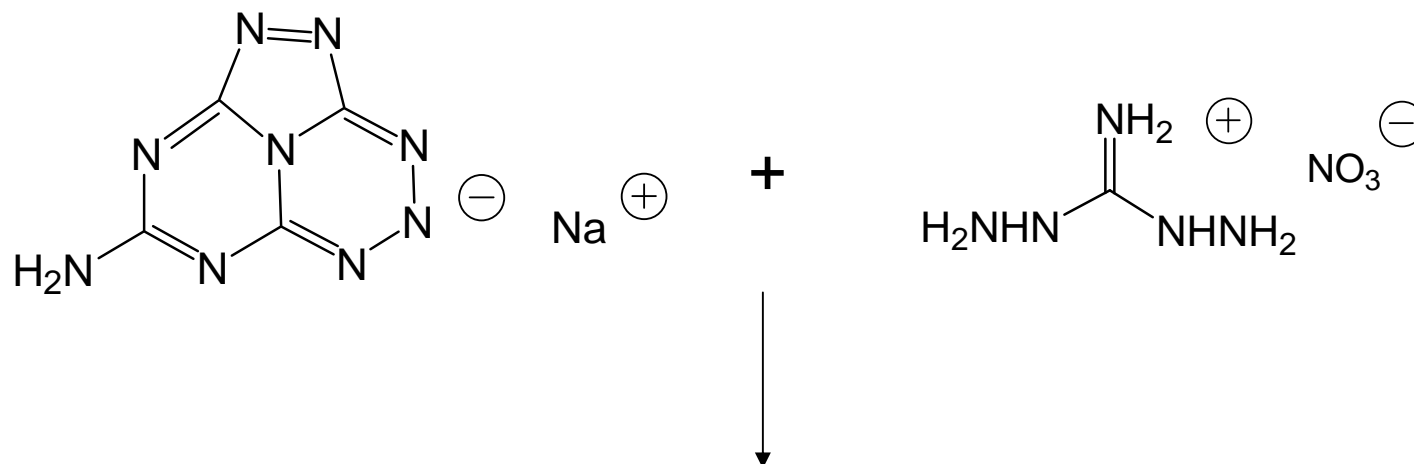
pKa ~ 4
(calculated)

$\Delta H_f = 127.6$ kcal/mol
721 cal/g

Tetrazinyl Acid - Base Reaction

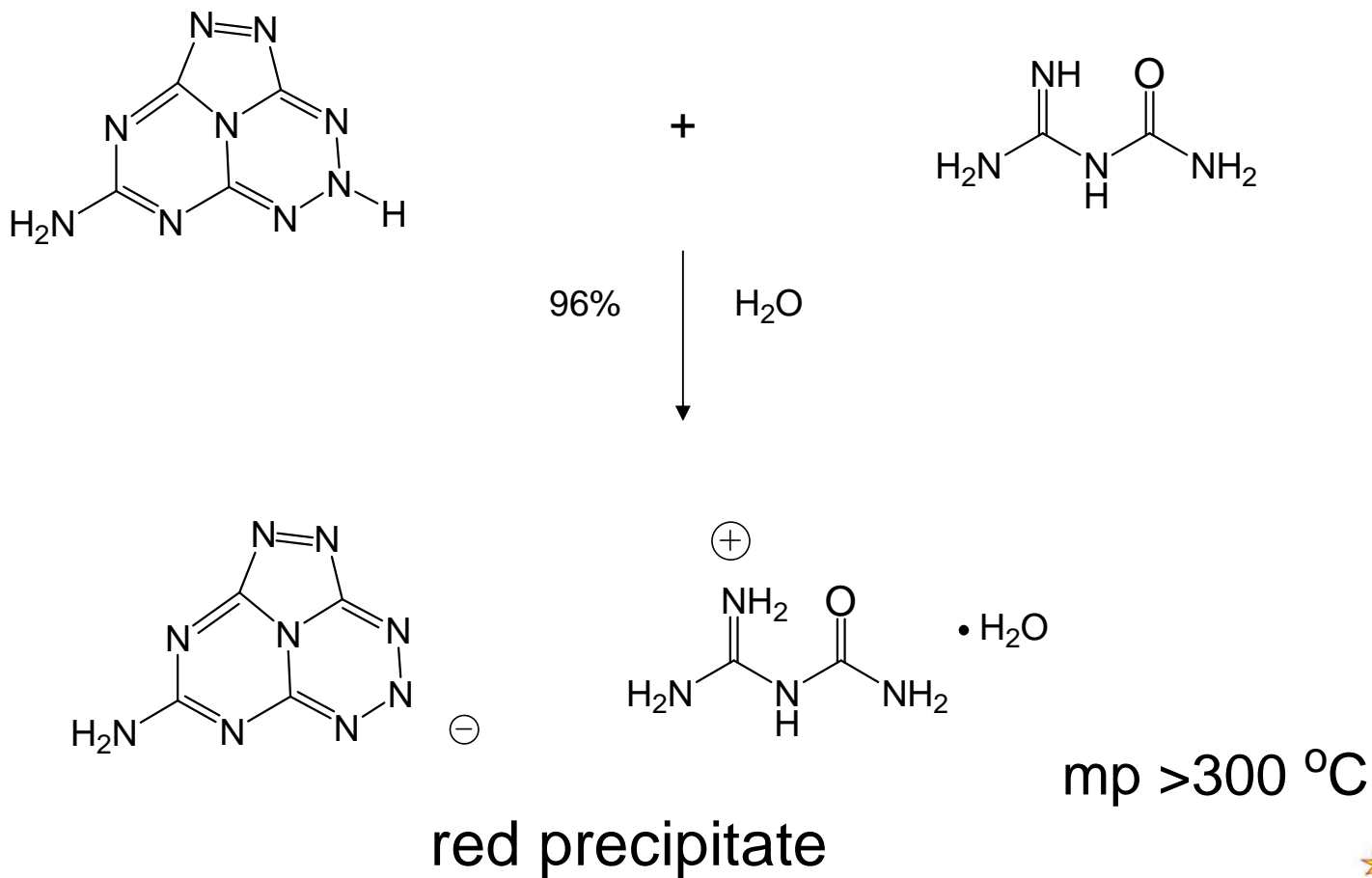


Metathesis Synthesis

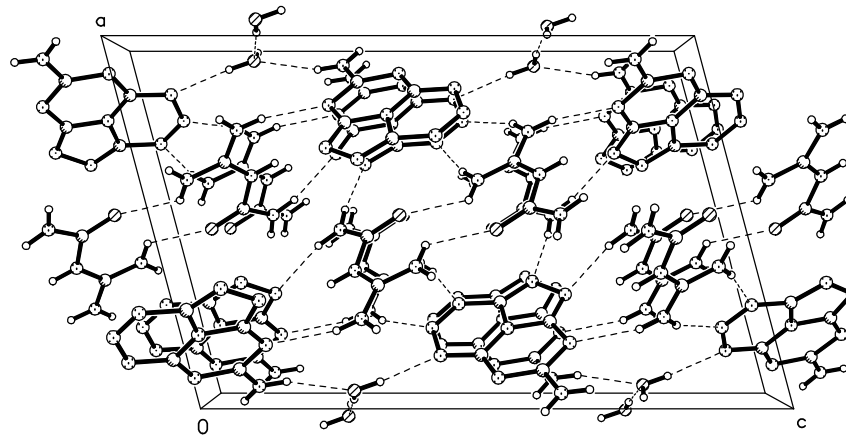
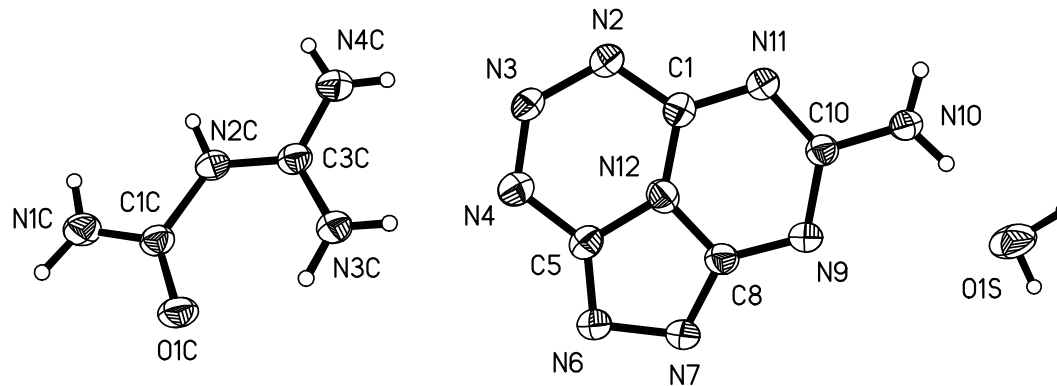


	Impact	Friction
DAG salt	76 cm	>980
RDX	14 cm	180

Guanylurea Salt Preparation



Crystal Structure and Packing for TATTz-GU Salt

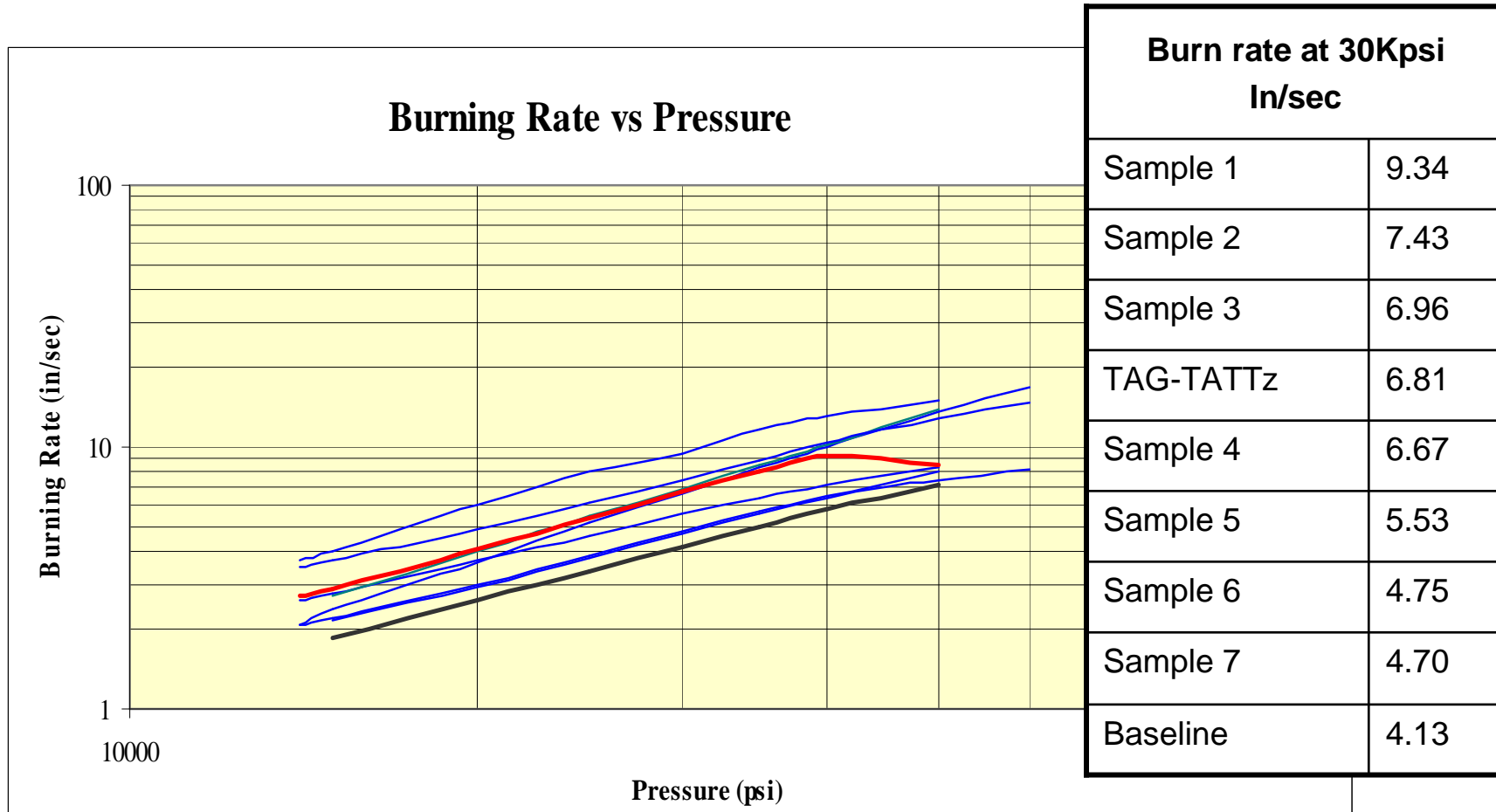


Crystal structure and packing by R. Gilardi, NRL

TATTz and its Salts: Sensitivity and Energy Content

Cation	Impact (cm)	Friction (psi)	ESD (J)	DSC	%N	ΔH_f (cal/g)
DHT ⁺	112	>960	0.015	165	74.6	1102
TAG ⁺	282	>960	0.165	206	70.2	1060
H ⁺	17	<30	0.008	213	71.1	721
NH ₂ NH ₃ ⁺	17	<75	0.023	201	73.7	689
NH ₄ ⁺	>320	>960	0.095	--	64.9	611
DAG ⁺	76	>960	0.095	206	73.7	384

Burning Rate Modifiers



Data supplied by Dr. C. Michienzi and Ms. C. Knott of NSWC IHD

Summary

- TATTz is the first example of a 1,2,3,5-tetrazinyl acid with a CHN composition. Similar high-energy compounds possible via Pschorr ring formation reactions.
- High-nitrogen bases react with TATTz to form insensitive propellant ingredients.
- TAG-TATTz in upper tier of burning rates found in a group of high-nitrogen compounds tested in closed-bomb combustion tests.

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