

Energetics Science & Technology Outside the United States



Professor James Short
jshort@umd.edu
301 405-5246



CECD

CENTER FOR ENERGETIC CONCEPTS DEVELOPMENT



DEPARTMENT OF MECHANICAL ENGINEERING
A. JAMES CLARK SCHOOL OF ENGINEERING



Energetics Science & Technology Outside the United States

1970s

Berkeley
UNIVERSITY OF CALIFORNIA

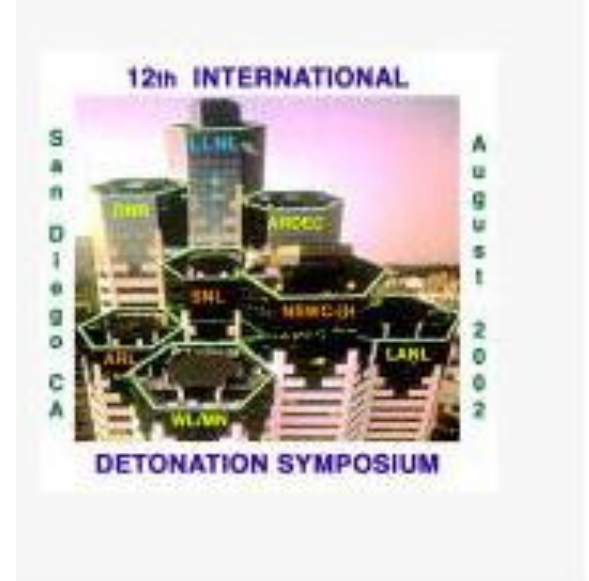
1980s



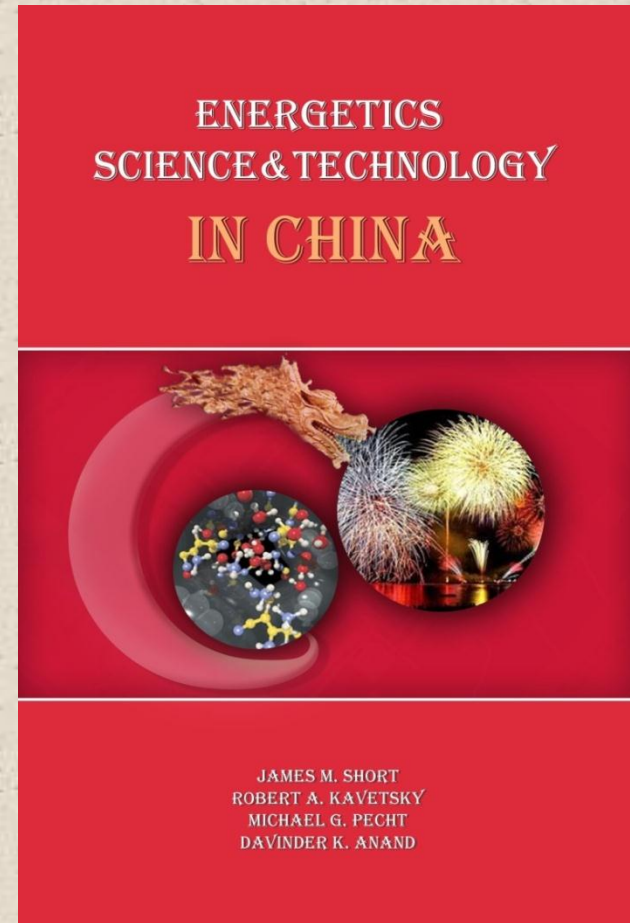
The Legacy of the
White Oak Laboratory



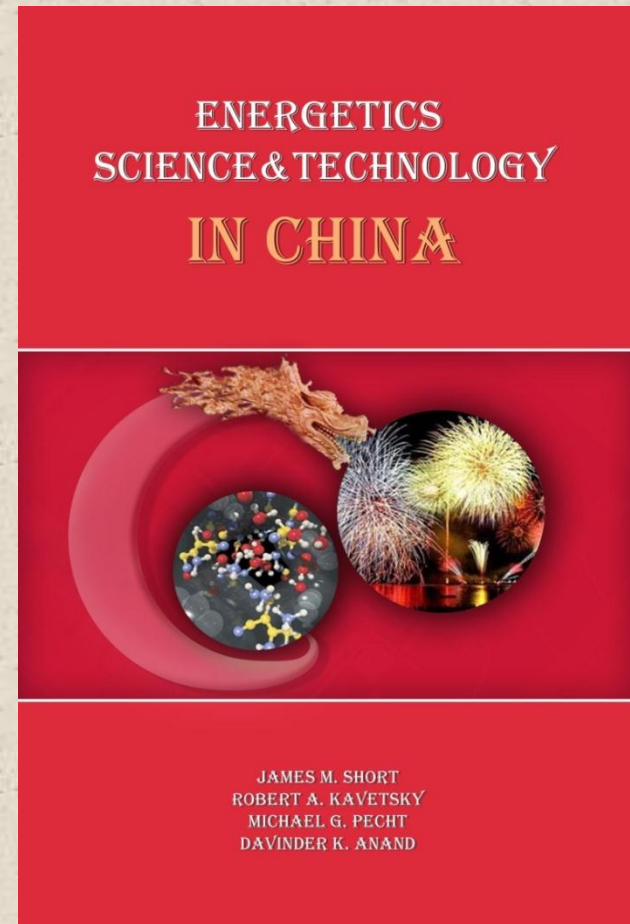
1980s & 1990s



Energetics Science & Technology Outside the United States



Energetics Science & Technology Outside the United States





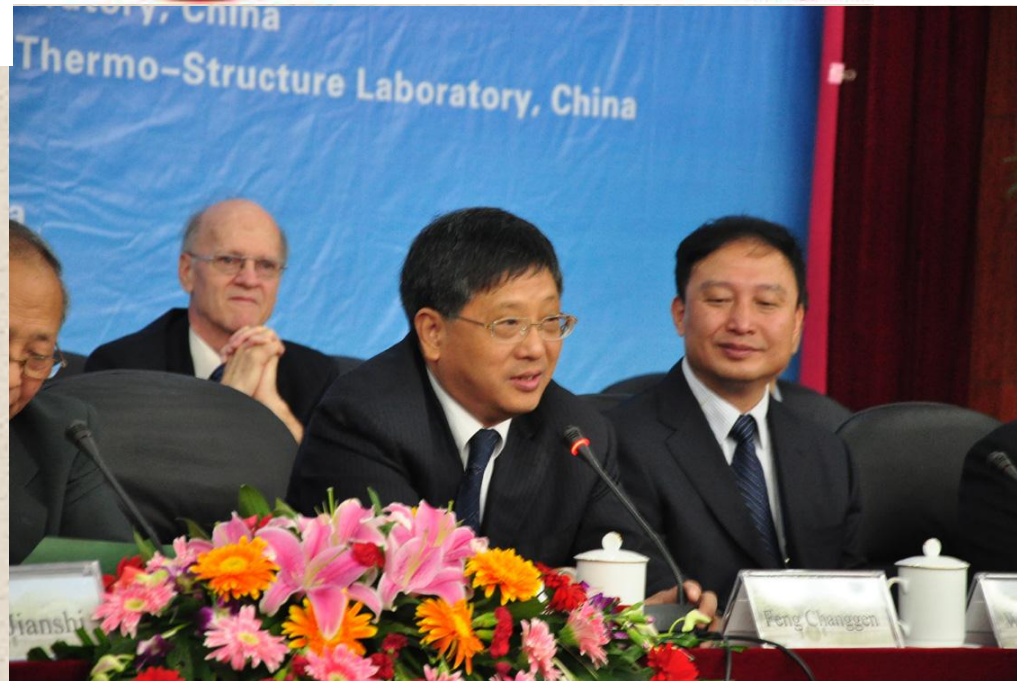
Energetics
Science & Technology
Outside the United States

China

2011 International Autumn Seminar on Propellants, Explosives & Pyrotechnics



Energetics Science & Technology Outside the United States



Energetics Science & Technology Outside the United States



Energetics Science & Technology Outside the United States



- Experimental methods of detonation physics
- Spectroscopy
- Molecules @ high density
- Clusters of explosive molecules
- Detonation product chemistry
- Intermolecular forces
- Spectroscopy of shocked materials
- Diagnostics of shocked materials
- Diagnostics of detonating materials
- Real-time studies
- Spectroscopy of highly excited molecules

Energetics Science & Technology Outside the United States



- Energetics synthesis chemistry
 - Organic energetics—
 - CHNOF
 - Metals & beyond
 - Inorganic energetics
 - All nitrogen & all hydrogen
- Energetic formulation chemistry
- Thermobarics
- Reactive materials
- Fragments that are independently inert & react when striking target
- Physics & chemistry of reaction
- Gun propellants
- Nanomaterials in formulations
- Energetics manufacturing science
 - Batch processing
 - Extruder (or twin-screw) processing
 - Barriers to scale-up

Energetics Science & Technology Outside the United States



- Energetics Fundamental Research domains China expects to pursue:
- Theoretical & experimental methods providing fundamental understanding of detonation physics and energetics chemistry.
- Theoretical methods of detonation physics
 - Ab initio intermolecular potentials
 - Dense molecular fluids
 - Semi-empirical molecular potentials
- Hydrodynamics
 - Shocked-state measurements
 - Unreacted equations of state
 - Experimental diagnostics of shocked material
 - Shocked state measurements
 - Detonation state measurements
- Computational fluid dynamics

THEORY AND PRACTICE
OF ENERGETIC MATERIALS

(VOL. IX)

Edited by

LI Shengcai
NIU Peihuan

 Science Press
Science Press USA Inc.

THEORY AND PRACTICE
OF ENERGETIC MATERIALS

(VOL. IX)

Edited by

LI Shengcai
NIU Peihuan

 Science Press
Science Press USA Inc.

THEORY AND PRACTICE
OF ENERGETIC MATERIALS

(VOL. IX)

Edited by

LI Shengcai
NIU Peihuan

 Science Press
Science Press USA Inc.

SECTION ONE
SYNTHESIS AND MANUFACTURE

42 papers, 26 Chinese papers

- hexa-nitrohexaaza-iso-wurtzitane,
- tetrazines ($C_6N_{12}H_6O_{12}$)
- nano-HMX
- FOX-7 ($C_2H_4N_4O_4$)
- furoxan ($C_2H_2N_2O_2$)
- energetic polymers e.g., glycidal azide polymer
- high nitrogen salts
(e.g., nitro-amino tetrazoles, CH_2N_4)
- lead-free primary explosives

THEORY AND PRACTICE
OF ENERGETIC MATERIALS

(VOL. IX)

Edited by

LI Shengcai
NIU Peihuan

 Science Press
Science Press USA Inc.

SECTION TWO
CHARACTERIZATION AND ANALYSIS

38 papers, 29 Chinese papers

- furoxans ($C_2H_2N_2O_2$)
- HTPB propellants
- ammonium nitrate (NH_4NO_3)
- ammonium perchlorate (NH_4ClO_4)
- ammonium dinitramide ($H_4N_4O_4$)
- characterization of high nitrogen materials
- pyrotechnic materials and molding powders
- thermal decomposition
- effects of aging
- crystal defects
- dynamic fracture

THEORY AND PRACTICE
OF ENERGETIC MATERIALS

(VOL. IX)

Edited by

LI Shengcai
NIU Peihuan

 Science Press
Science Press USA Inc.

SECTION THREE
COMBUSTION AND DETONATION

81 papers, 53 Chinese papers

- shaped charges
- explosively formed penetrators
- pore collapse initiation
- chain branching reaction mechanisms
- structural integrity of solid rocket propellant

THEORY AND PRACTICE
OF ENERGETIC MATERIALS

(VOL. IX)

Edited by

LI Shengcai
NIU Peihuan

 Science Press
Science Press USA Inc.

SECTION FOUR
MODELING AND CALCULATION

21 papers, 13 Chinese papers

- “*A Microscopic Model Predicting Hot-spot Ignition of Energetic Crystals under Drop-weight Impact*” by Wu & Huang
- Harold Sandusky & Steve Coffey
- Micro-mechanics model of HMX hot spot ignition in drop-weight impact test
- Meso-scale model
 - particle-particle contact, no sliding friction,
 - contact between particles & anvil
 - sliding friction heating induces plastic deformation & melting along the maximum shear stress faces

THEORY AND PRACTICE
OF ENERGETIC MATERIALS

(VOL. IX)

Edited by

LI Shengcai
NIU Peihuan

 Science Press
Science Press USA Inc.

SECTION FIVE
MISCELLANEOUS
12 papers, 7 Chinese papers



Energetics
Science & Technology
Outside the United States

China



Energetics
Science & Technology
Outside the United States

China



Energetics Science & Technology Outside the United States

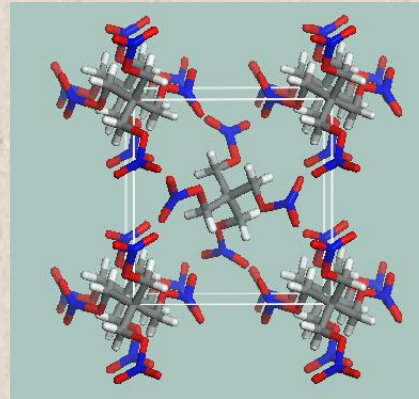
Xi'an Modern Chemistry Research Institute (largest chemical energetics research center)
Beijing Institute of Technology (Project 985 Tier 2)
Nanjing University of Science & Technology (Project 985 Tier 2)
China Academy of Engineering Physics @ Mianyang (nuclear weapon design)

A distant 4th is North University of China (ordnance, defense industry college)

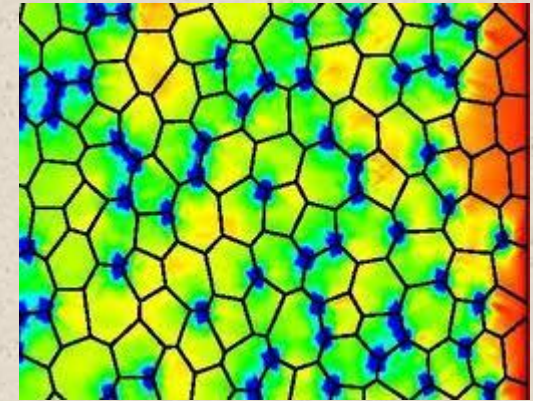
Followed by

National University of Defense Technology (Project 985 not Tier 2)
2nd Artillery Engineering Institute (strategic nuclear establishment)
University of Science & Technology of China (C9 League member, 154th @ US News ranking)
Northwest University @ Xi'an (Project 985 not Tier 2, defense industry college)
Southwest University of Science & Technology (founded in 2000)
213th Research Institute of China (armor)
Tianjin University (Project 985 not Tier 2)

Energetics Science & Technology Outside the United States



Molecular Scale



Mesoscale