Emerging Energetic Materials: Synthesis, Physicochemical, and Detonation Properties

Dabir S. Viswanath · Tushar K. Ghosh
Veera M. Boddu

Emerging Energetic Materials: Synthesis, Physicochemical, and Detonation Properties

Springer

Dabir S. Viswanath
Nuclear Science and Engineering Institute
University of Missouri
Columbia, MO
USA

and

Nuclear Engineering Teaching Laboratory
Cockrell School of Engineering
Austin, TX
USA

Tushar K. Ghosh
Nuclear Science and Engineering Institute
University of Missouri
Columbia, MO
USA

Veera M. Boddu
Environmental Processes Branch
US Army Engineer Research and Development Center
Champaign, IL
USA

and

Plant Polymer Research Unit, National Center for Agricultural Utilization Research
Agricultural Research Service, US Department of Agriculture
Peoria, IL
USA

ISBN 978-94-024-1199-7 ISBN 978-94-024-1201-7 (eBook)
https://doi.org/10.1007/978-94-024-1201-7

Library of Congress Control Number: 2017951437

Printed on acid-free paper

This Springer imprint is published by Springer Nature
The registered company is Springer Science+Business Media B.V.
The registered company address is: Van Godewijckstraat 30, 3311 GX Dordrecht, The Netherlands

Preface

This monograph summarizes science and technology of select new generation high-energy and insensitive explosives. There is an enormous amount of information being generated and published in the open literature on different areas pertaining to civilian and military uses of these materials. The objectives of this monograph are to provide the professionals with comprehensive information on synthesis, physicochemical, and detonation properties of the explosives. Potential technologies applicable for treatment of contaminated waste streams from manufacturing facilities and environmental matrices are also included. This book provides the reader an insight into the theoretical and empirical models and experimental techniques currently being developed in the field of energetic materials. The material in this book should assist researchers involved in both sensitive and insensitive energetic materials, a program of the United States Department of Defense.

Physicochemical Measurements on Insensitive Munitions Compounds for Environmental Applications—Understanding the environmental impact of energetic materials is critical for their acceptance for use in weapons systems. Predicting their environmental distribution, biotransformation, and determining potential treatment processes assist both decision-makers and scientists in the development process. Combustion of explosives involves complex physicochemical changes and reaction mechanisms. Therefore, there is a need to have knowledge of accurate and good quality data on properties such as solubility, toxicity, enthalpies of formation and combustion, thermal properties, and a host of other properties. We have tried to put together as many properties available in the published literature. Since extensive testing to design high-energy insensitive munitions and formulations are expensive, this monograph should help researchers who use multiphysics modeling programs to achieve high-energy materials and formulations. Thermophysical properties collected in this monograph should be useful in 2-D numerical codes that will simulate slow and fast cook-off, and codes that simulate detonation properties.

This monograph has 11 chapters, and each chapter is devoted to one particular compound with the exception of Chap. 1. Chapter 1 deals with the measurements and estimations of several physical properties important to the characterization, screening, and utilization of energetic materials. It outlines different experimental methods of measurement of physical properties, and their limitations.

The remaining ten chapters are devoted to a set of new emerging energetic materials. Each chapter considers one energetic compound and enumerates the synthesis methods, structure, physical and chemical properties, decomposition and destruction, detonation characteristics, toxicity, explosive formulations, and detection of that compound. The compounds considered in this monograph are as follows: hexanitrohexaazaisowurtzitane (HNIW, CL-20), 1,1-diamino-2,2-dinitro ethylene (DADE, FOX-7), 2,4-dinitroanisole (DNAN), 5-nitro-2,4-dihydro-3H-1,2, 4-triazole-3-one (NTO), 1,3,3-trinitroazetidine (TNAZ), triacetone triperoxide (TATP), 1,3,5-triamino-2,4,6-trinitrobenzene (TATB), 1-azido-2-nitro-2-azapropane (ANAP), N-methyl-4-nitroaniline (MNA), and hexanitrostilbene (HNS). These compounds represent a cross section of sensitive high energetic materials such as TATP and insensitive energetic compounds that are used in different applications.

We have tried to present the current literature on these compounds, and bring together material scattered in different publications. The material presented in this monograph should supplement material found in several other books such as The Chemistry of Explosives by J. Akhavan, Propellants and Explosives by N. Kubota, Organic Chemistry of Explosives by J.P. Agrawal and R. Hodgson, High Energy Materials by J.P. Agrawal, Advanced Processing Technologies for Next-Generation Materials by T.M. Klapotke, Liquid Explosives by J. Liu, and others.

With great appreciation, we take this opportunity to thank the editors at Springer. The authors are thankful to the publishers for agreeing to our repeated requests to postpone submission of the manuscript. Special thanks are extended to Ms. Cynthia Feenstra for her coordination and patience in extending the deadline for submitting the manuscript. We also thank our family members for their support for realization of this book.

Columbia, MO, USA Dabir S. Viswanath
Columbia, MO, USA Tushar K. Ghosh
Peoria, IL, USA Veera M. Boddu

Contents