

Review

Highly Reactive Thermite Energetic Materials: Preparation, Characterization, and Applications: A Review

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Abstract: As a promising kind of functional material, highly reactive thermite energetic materials (tEMs) with outstanding reactive activation can release heat quickly at a high reaction rate after low-energy stimulation, which is widely used in sensors, triggers, mining, propellants, demolition, ordnance or weapons, and space technology. Thus, this review aims to provide a holistic view of the recent progress in the development of multifunctional highly reactive tEMs with controllable micro/nano-structures for various engineering applications via different fabricated techniques, including the mechanical mixing method, vapor deposition method, assembly method, sol-gel method, electrospinning method, and so on. The systematic classification of novel structured tEMs in terms of nano-structural superiority and exothermic performance are clarified, based on which, suggestions regarding possible future research directions are proposed. Their potential applications within these rapidly expanding areas are further highlighted. Notably, the prospects or challenges of current works, as well as possible innovative research ideas, are discussed in detail, providing further valuable guidelines for future study.

Keywords: energetic materials; nanostructures; thermites; systematic classification; exothermic performance; broad prospects

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1. Introduction

Energetic materials (EMs), regarded as a kind of promising functional material, can generate enormous amounts of thermal energy at a high rate of heat release within a surprisingly short time (< 1 s) after a small energy stimulation, and are widely used in the fields of sensors, trigger, mining, propellants, demolition, ordnance or weapons, civilian and military [1–4]. With the rapid development of nanotechnology, designing nano-energetic materials (nEMs) with nanostructured-fuel and oxidizer has attracted increasing attention, especially in the last two decades [5,6]. Compared with traditional micro-EMs, nEMs have a faster burning rate and a more intense loading process due to a larger contact area and shorter mass transfer distance among reactants during the exothermic reaction process [7,8], and their superior structure and performance advantages allow them to exhibit wider application potentials in micro-electro-mechanical systems (MEMS), lab-on-a-chip devices, miniaturized or sophisticated weapons and equipment [9–14].

As the promising subclass of nEMs, highly reactive thermite EMs (tEMs) with an outstanding heat release ability due to high reaction enthalpy have drawn increasing interest and have wide application prospects in the fields of sensors, microelectronics, propeller machinery, miniaturized detonating primers and advanced military industry

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Molecular Materials Sanjay Malhotra, B. L. V. Prasad, Jordi Fraxedas, 2017-05-12 The field of molecular materials research looks at the preparation and characterization of potentially useful materials with enhanced physical chemical and biomedical properties Molecular Materials Preparation Characterization and Applications discusses the cutting edge interdisciplinary research in the area of advanced molecular based materials This book explores multiple aspects of molecular materials including their synthesis and characterization and gives information on their application in various fields **NBS Special**

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Dincer, C. Ozgur Colpan, Onder Kizilkan, M. Akif Ezan, 2015-08-27 This expansive reference on clean energy technologies focuses on tools for system modelling and analysis and their role in optimizing designs to achieve greater efficiency minimize environmental impacts and support sustainable development Key topics ranging from predicting impacts of on grid energy storage to environmental impact assessments to advanced exergy analysis techniques are covered The book includes findings both from experimental investigations and functional extant systems ranging from microgrid to utility scale implementations Engineers researchers and students will benefit from the broad reach and numerous engineering examples provided

Advances in Thermal Energy Storage Systems Luisa F. Cabeza, 2014-10-31 Thermal energy storage TES technologies store thermal energy both heat and cold for later use as required rather than at the time of production They are therefore important counterparts to various intermittent renewable energy generation methods and also provide a way of valorising waste process heat and reducing the energy demand of buildings This book provides an authoritative overview of this key area Part one reviews sensible heat storage technologies Part two covers latent and thermochemical heat storage respectively The final section addresses applications in heating and energy systems Reviews sensible heat storage technologies including the use of water molten salts concrete and boreholes Describes latent heat storage systems and thermochemical heat storage Includes information on the monitoring and control of thermal energy storage systems and considers their applications in residential buildings power plants and industry **Phase Change Materials for Thermal**

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