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共轴聚焦型微流控装置剪切高粘溶液连续制备双基球形发射药

Continuous Preparation of Double-based Spherical Propellants by Shearing High Viscosity Solution with A Co-axial Flowing Microfluidic Installation

2023
第31卷 4

HANNENG CAILIAO

共轴聚焦型微流控装置剪切高粘溶液连续
制备双基球形发射药



球形发射药由于装填密度高、流散性好等优点,常应用于中小口径武器。粒径范围在一百微米以内的球形发射药,随着粒径的减小可以显著提高燃速和膛压,但随之会影响武器的安全性能;研究发现通过减小球形发射药的粒径分布可有利于提高武器的射击精度。以上要求对百微米范围内的球形发射药的制备是一个新的挑战,与新式武器装备的实际应用还有一定差距。来自西南科技大学裴重华等研究人员选用共轴聚焦型结构芯片为液滴生成装置,设计并合成了粒径范围在一百微米以内的双基球形发射药。本设计通过高压输液泵为流体输送装置可精准且连续输送流体并可进一步提高分散相浓度。结果表明:通过调控两相流量比的大小与芯片的尺寸,可成功制备出粒径在400~700 μm 的双基球形发射药;通过调控两相流量比能够改变液滴的生成模式,可达到调控颗粒的大小及粒径分布的目的,颗粒 D_{50} 随两相流量比的减小而先增大后减小,最大 D_{50} 为540 μm ;调控芯片尺寸能改变液滴的生成时间从而调控颗粒大小,颗粒 D_{50} 随分散相或连续相通道内径的增大而增大;双基球形发射药内部密实,其燃烧规律为减面燃烧且燃烧稳定。

穿越火“钱”

封面以波涌的水面为背景,简明地交待了文章的研究对象为含有发射药的剪切高粘溶液;图片正中央描述的是一发子弹正在精准地穿过悬浮于水面上空的铜钱,子弹对准铜钱中央的小孔表明均一的双基球形发射药能保证子弹的精准打击;图片下方是微流控装置最核心的结构——芯片;作为水流源头,芯片周围时时有水流环绕,水流中整齐排列的圆球代指双基球形发射药,表明微流控技术能连续制备出均一稳定的双基球形发射药,并最终流向实际应用——子弹;巧妙的流水设计在表现芯片能够微流控液体的同时,也可为武器的精准打击保驾护航。

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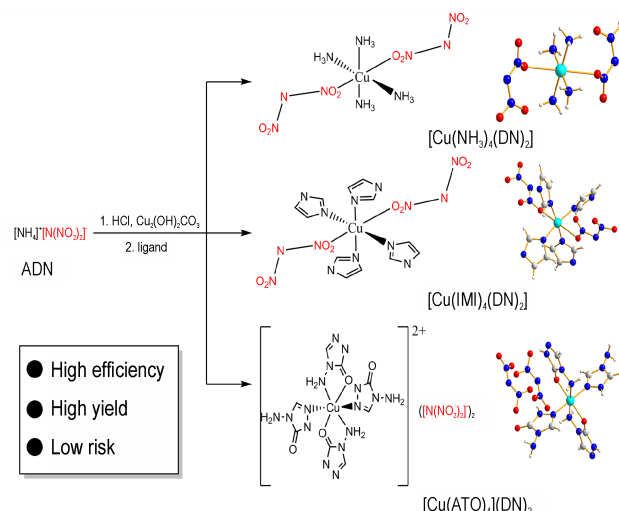
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Preparation and Property

Syntheses and Characterizations of New Energetic Dinitramide Nitrogen-rich Copper Complexes

MU Guo-zhu, LI Xin, LI Shuang, LEI Qing, YUE Si-jia, GAO Yang

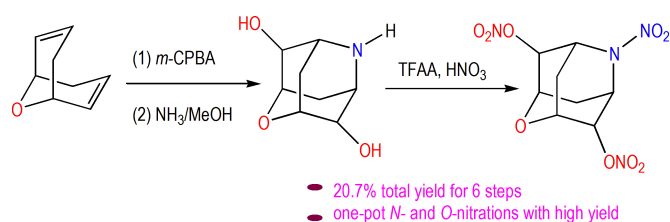
P317 Three new energetic dinitramide nitrogen-rich copper complexes were prepared from ammonium dinitramide (ADN) by ion exchange reaction in two mild steps. The single crystal structures of the energetic complexes were characterized accurately by X-ray single crystal diffraction. Investigations on the sensitivity, thermal stability, hygroscopicity and the effects on the burning rate of HTPB propellant were performed in detail with desired results.



Synthesis and Characterization of 6-nitro-2-oxa-6-azaadamantane-4,8-diol dinitrate

LIU Yun-zhi, CAI Rong-bin, HOU Tian-jiao, WANG Gui-xiang, LUO Jun

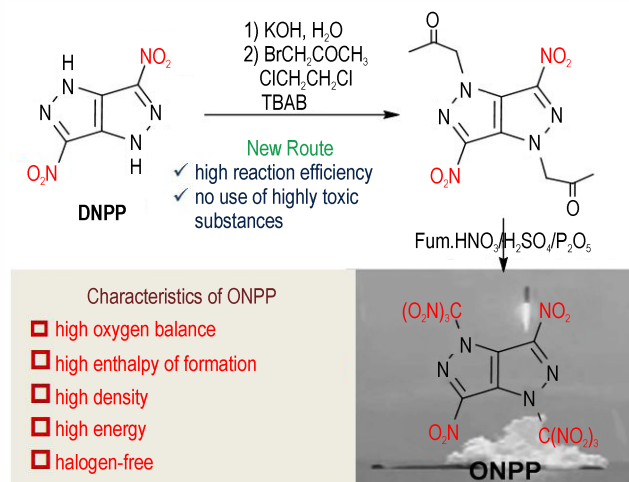
P325 A facile protocol for constructing the skeleton of 2-oxa-6-azadamantane-4,8-diol from cycloocta-1,5-diene was developed, and a new thermal stable and cage-like energetic compound 6-nitro-2-oxa-6-azaadamantane-4,8-diol dinitrate was synthesized via one step N- and O-nitrations with high yield. It shows that introduction of oxygen atoms on the adamantane skeleton can effectively improve the oxygen balance and increase the density, thereby significantly increasing the detonation velocity and pressure. Therefore, introduction of oxygen atoms on the adamantane skeleton is of great significance for the design and application of adamantane-containing energetic compounds.



Synthesis and Performance of High-Energy Oxidizer ONPP

YAN Chao, SUN Rui, ZHU Jin-li, REN Xiao-ting, LU Yan-hua, HE Jin-xuan

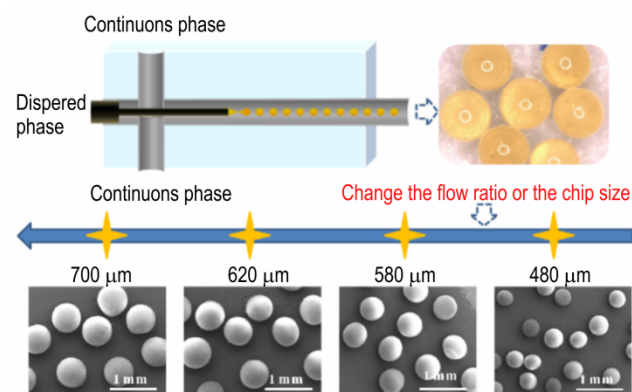
P332 A new synthetic process of the promising oxidizer 1,4-bis (trinitromethyl)-3,6-dinitropyrazole [4,3-c] pyrazole (ONPP) from 3,6-dinitropyrazole[4,3-c]pyrazole (DNPP) was demonstrated with the total yield of 31%. The crystal structure of ONPP and energy levels of ONPP-based formulations were also studied.



Continuous Preparation of Double-based Spherical Propellants by Shearing High Viscosity Solution with A Co-axial Flowing Microfluidic Installation

XIE Yu-xin, YANG Ling-feng, LI Yang, SHI Xian-rui, ZHU Juan, LI Zhao-qian, PEI Chong-hua

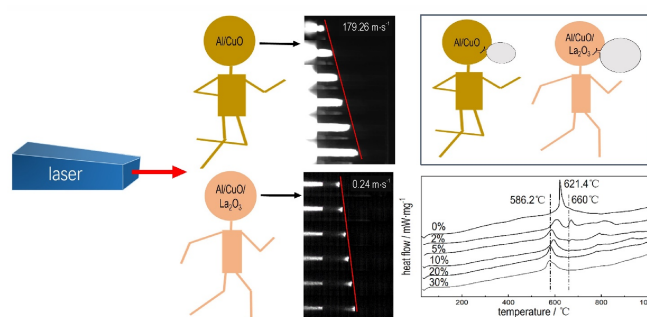
P338 To explore the processing parameters for continuous production of double-based spherical propellants with particle sizes in the range of hundred microns, a Co-axial flowing microfluidic installation was used to shear the high viscosity solution by varying the two-phase flow ratio and chip size, so that the double-based spherical propellants with the controllable particle sizes in the range of 400–700 μm were prepared.



Reactive Characteristics of La_2O_3 -Doped Al/CuO Thermite

CHEN Zhi-yi, SHI An-ran, ZHANG Wei, SHEN Rui-qi, YE Ying-hua

P347 Al/CuO with 1.0, 1.4 and 1.8 equivalent ratios were prepared by mechanical mixing method. La_2O_3 was doped into Al/CuO to study its effect on combustion characteristics, gas production performance and thermal properties. The powder was filled into a quartz tube and a laser beam was used to irradiate the surface. The end-face displacement change can be seen in the high speed video when the sample burn. Ignition temperature and gas production performance were tested by T-jump and pressure cell test. DSC results provide data reference for thermal properties.

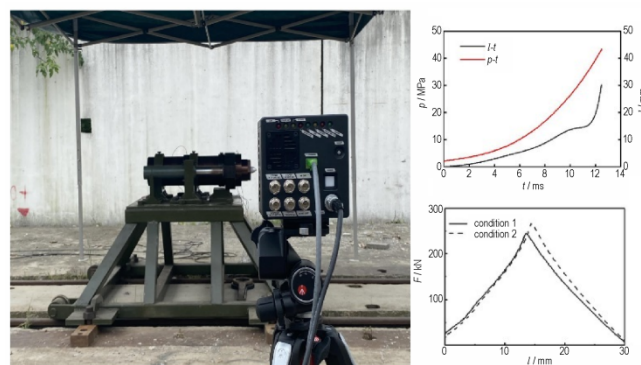


Calculation and Simulation

Experimental Study and Numerical Analysis of Dynamic Engraving Characteristics of Nylon Belt

YANG Ming, YU Yong-gang

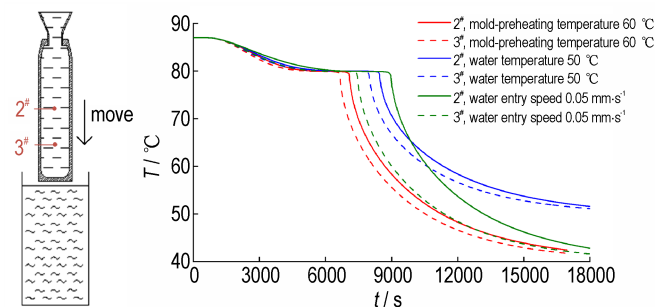
P356 The short tube gun launching device was designed and the projectile firing test with nylon band was carried out. The dynamic engraving resistance characteristics of the projectile at different pressure increasing rates were investigated. A three-dimensional engraving model was established for numerical calculation.



Simulation Study on the Effects of the Process Parameters of Sequential Solidification on the Quality of Casting Charge

NIU Kai-bo, CAO Hong-song, LIU Heng-zhu, SHI Hui-fang, WANG Zhao-guo, YI Mao-guang

P365 A simulation method was applied to improve the charge solidification quality based on ProCAST software. The simulated shrinkage volume can be reduced by 74% after a process program optimization. The solidification process of TNT/RDX (33.8/65) explosive based on TNT and RDX was taken as an example to simulate the downward movement of the mold and the process of the sequential solidification of liquid explosives. The effects of different process parameters (water injection speed, water temperature, preheating temperature of mold) on the temperature field and shrinkage defects of the explosive solidification process were studied.

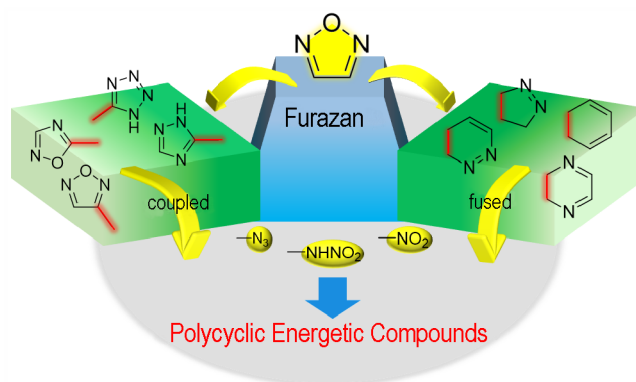


Reviews

Synthetic Progress of Furazan based Polycyclic Energetic Compounds

SHI Jun-hao, ZHANG Wen-quan, ZHANG Qing-hua

P374 There are two synthetic strategies for the construction of furazan based molecular skeletons, including coupling and fusing. A variety of polycyclic energetic compounds can be obtained after further derivatization. This review article summarized and evaluated the molecular structures, synthetic methods, physicochemical properties of furazan based polycyclic energetic compounds. The potential applications of these compounds in high energy and low sensitivity explosives, heat-resistant explosives and primary explosives were also prospected.



Advances in the Application of Hyphenated Techniques in the Thermal Analysis of Energetic Materials

WANG Chen, WAN Chong, CHEN Su-hang, MA Hai-xia, ZHAO Feng-qi, XU Kang-zhen

P411 The advances in the application of TG-DSC, TG-MS, TG-FTIR-MS, TG-FTIR-GC-MS and Thermolysis/RSFTIR hyphenated techniques in the research of energetic materials are fully reviewed in this paper. The advantages and insufficiencies of these thermal analysis hyphenated techniques are analyzed and discussed, as well as an outlook on their future development.

