Defence Technology xxx (2017) 1–6

Contents lists available at ScienceDirect

Defence Technology

journal homepage: www.elsevier.com/locate/dt

Electrostaticspray preparation and properties of RDX/DOS composites

Jian Yao*, Jian Liu, Yong-xu Wang, Bin Li, Li-feng Xie

School of Chemical Engineering, Nanjing University of Science and Technology, Jiangsu, Nanjing 210000, PR China

ARTICLE INFO

Article history:
Received 13 January 2017
Received in revised form
31 March 2017
Accepted 10 May 2017
Available online xxx

Keywords:
RDX
DOS
Electrostaticspray
Composites
Insensitive

ABSTRACT

A composite explosive based on 1, 3, 5-trinitro-1, 3, 5-triazinane (RDX) was prepared by electrostaticspray method with dioctyl sebacate (DOS) as desensitizer. After preparation, the particle size and crystal structure were characterized and chemical features, such as chemical bonds, functional groups, thermal decomposition parameters and mechanical sensitivity were investigated as well. In terms of the morphologies of the composites, the particle sizes were in the range of 1–3 μm. Compared with RDX, the crystal types, chemical bonds and functional groups of the RDX/DOS composites were unchanged. The activation energy of the composites was lower than that of raw RDX, and the 3wt % DOS composites had the lowest activation energy. The impact sensitivity and friction sensitivity of the RDX/DOS composites were lower than those of raw RDX, and the 10wt% DOS composites had the highest H_{50} (125.9 cm) and the lowest friction sensitivity (8%).

1. Introduction

The improvement in the energy of one explosive always brings the increase in its sensitivity, which results to the development of compound explosives. RDX is one of the common explosives with great power and high mechanical sensitivity. How to reduce sensitivity of RDX as well as maintain a high energy is a challenging question [1–7]. DOS, an oily substance, can be used to coat RDX and the excellent sensitivity of the RDX/DOS composites has been proved [8,9]. In the production of RDX-based composite explosives, it is common to combine RDX and DOS together with traditional mixing method (mixing and stirring) [10–14], but the uniformity of mixture cannot be maintained well and fundamental changes on the characteristics of mixture components were never found. It is meaningful to develop a new method to update the mixing process.

In this paper, we demonstrated the preparation of the RDX/DOS composites by electrostaticspray method, which was used to break molten liquid or solution into tiny droplets by the electrostatic field force, had successfully been used to produce uniform nanometer-sized particles [15–21]. However, insufficient researches had been conducted into electrostaticspray method in the field of energetic materials. In this work, RDX-based composites with DOS were prepared by electrostaticspray. Furthermore, the properties of the composites were characterized and analyzed in detail.

2. Materials and methods

2.1. Materials

Raw RDX (99.9%) was provided by Jiangsu Yongfeng Machinery Co. Ltd.; DOS (AR, 97%) was provided by Aladdin Reagent (Shanghai) Co. Ltd; acetone (AR, 99.5%) was provided by Shanghai Lingfeng Chemical Reagent Co. Ltd.

2.2. Preparation of the RDX/DOS composites

RDX and DOS (1000 mg in total, and the mass ratios of F2604 to RDX were 1:99, 3:97, 5:95 and 10:90, respectively) were dissolved in acetone (25 ml) to form a solution. As shown in Fig. 1, the RDX/DOS composites were prepared by electrostaticspray method. The solution was sprayed in four injection syringes by the TYD01-02 Syringe Pump (Lead Fluid Ltd., China). The voltage was 19 kV, which was provided by the high voltage direct-current power supply (Dongwen High Voltage Power Supply (Tianjin) Ltd., China), the flow rate of solution in the injection syringe was 1 ml h^{-1}, and the receiving distance was 10 cm. The composite particles were collected on aluminum foils.

* Corresponding author.
E-mail addresses: yaojian216@163.com (J. Yao), 1121270251@qq.com (J. Liu), 876002529@qq.com (Y.-x. Wang), wrilber@sina.com (B. Li), xielifeng319@sina.com (L.-f. Xie).

Peer review under responsibility of China Ordnance Society.

http://dx.doi.org/10.1016/j.dt.2017.05.002

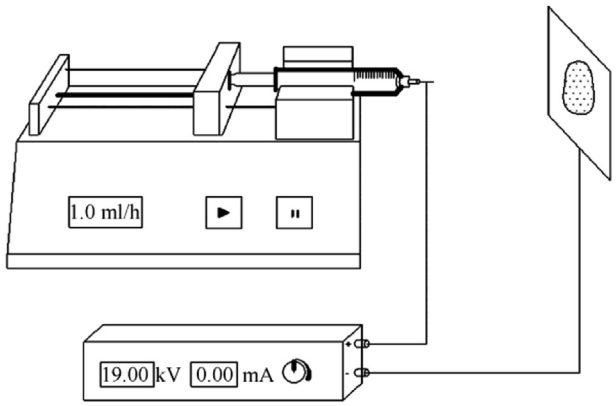

Fig. 1. The experimental set up.

2.3. Characterization

The morphologies and sizes of the RDX/DOS composite particles were studied by QUANTA 250 FEG scanning electron microscope (SEM) (FEI Ltd., America) with an electron beam spot of 2.0 and a generator voltage of 15 kV.

The chemical bonds and functional groups were studied by VERTEX70 fourier infrared spectrometer (FT-IR) (Bruker Ltd. Germany) with the spectral area of 500–4000 cm^{-1}.

The crystal structure was studied by the D8 advance X-ray diffractometer (XRD) (Bruker Ltd. Germany) with Cu-Kα radiation at a generator voltage of 40 kV and a generator current of 200 mA. The scan range in 2θ was from 10° to 60°.

The thermal decomposition properties of the composites were studied by DSC1 differential scanning calorimeter (DSC) (Mettler Toledo Ltd. Switzerland) with closed stainless steel crucibles and about 0.7 mg of samples. The analysis was performed under a pure nitrogen atmosphere (50 ml min^{-1}) at the heating rates of 1, 2, 4, 10 $K \cdot min^{-1}$ and the temperature was tested from 160 °C to 280 °C.

2.4. Tests of mechanical sensitivity

The impact sensitivity of the RDX/DOS composites was tested with a sample mass of 30 ± 1 mg and a drop weight of 2 kg. Two groups of each sample and 25 same samples from each group were tested. The results were shown in terms of the critical drop-height

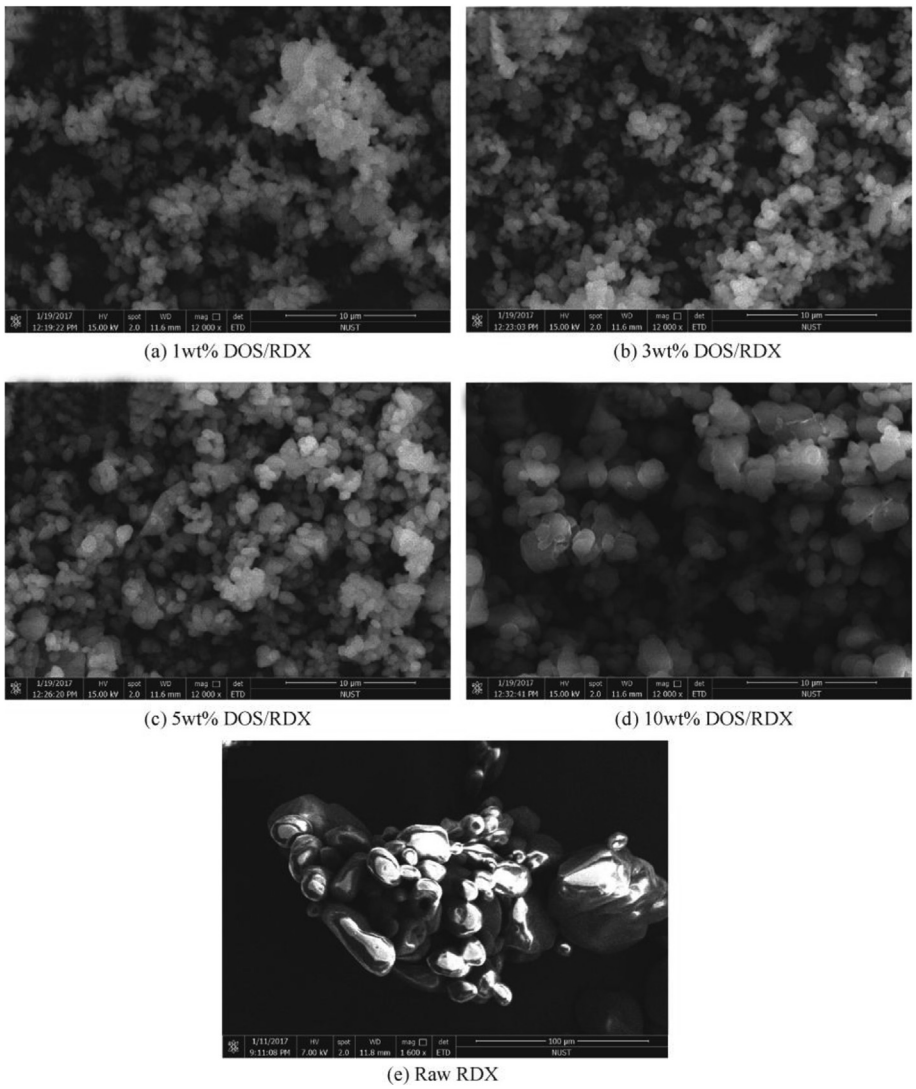

Fig. 2. The SEM images of raw RDX and the RDX/DOS composites.

Please cite this article in press as: Yao J, et al., Electrostaticspray preparation and properties of RDX/DOS composites, Defence Technology (2017), http://dx.doi.org/10.1016/j.dt.2017.05.002