RDX-based Nanocomposite Granules for Significantly Reduced Shock Sensitivity

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We report a novel, yet simple one-step spray-drying approach to create cyclotrimethylenetrinitramine (RDX) -based nanocomposite granules which demonstrated significantly reduced shock sensitivity. Starting with an acetone solution of RDX and polyvinyl acetate (PVAc), RDX/PVAc explosive granules were produced by atomizing the precursor solution and sequential drying using a commercially available spray dryer. The morphology, composition, and internal nanostructure of the granules were characterized using scanning electron microscopy (SEM), transmission electron microscopy (TEM), high-performance liquid chromatography (HPLC), x-ray diffraction (XRD), and confocal microscopy. Our characterization shows we obtained ~15 micrometers-sized nanocomposite granules in which small RDX crystals, in the range of around one hundred nanometers to a few micrometers, were uniformly and discretely dispersed in the PVAc binder. We attribute this desired nanostructure to the near-simultaneous and rapid precipitation of RDX and PVAc during spray drying. The nanocomposite explosive granules were subsequently pressed to produce a dense explosive material which exhibited significantly reduced shock sensitivity in comparison to known similar RDX-based explosives. The low sensitivity is believed to be related to the small crystal size as well as small void size which was ~250 nm shown by our characterization. The novel method developed in this work appears to have tremendous manufacturing potential since spraying drying is a well-established, cost-effective method. Furthermore, the simplicity of our all-liquid precursor makes the spray drying process easy and straightforward without concerns associated with handling of small crystals. More fundamentally, the results from this investigation provide an important insight as to how a new class of explosive materials could be designed and produced for insensitive munitions applications.