Characterization of Voids in an Insensitive RDX-based Nanocomposite Explosive

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Hongwei Qiu, Tsengming Chou, and Woo Y. Lee
Department of Chemical Engineering and Materials Science
Stevens Institute of Technology

Victor Stepanov, Ashok Surapaneni, and Anthony R. Di Stasio
Energetics, Warheads, and Environmental Technology
U.S. Army - Picatinny Arsenal

Shuang Zhang, Visualization Sciences Group

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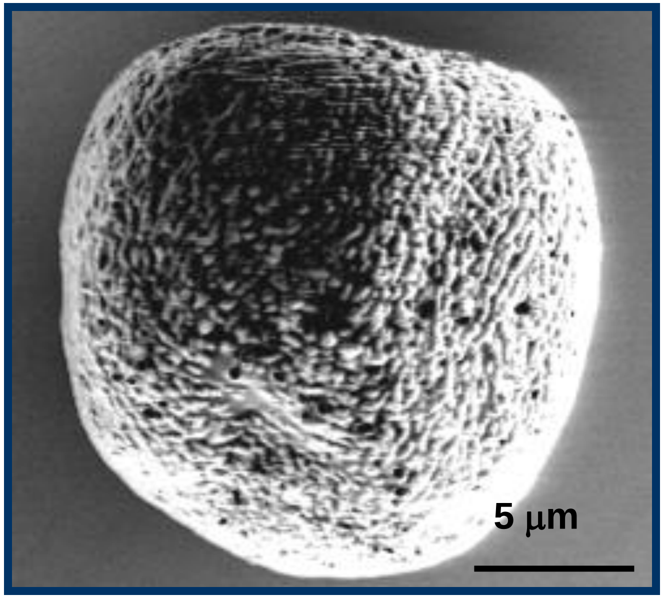
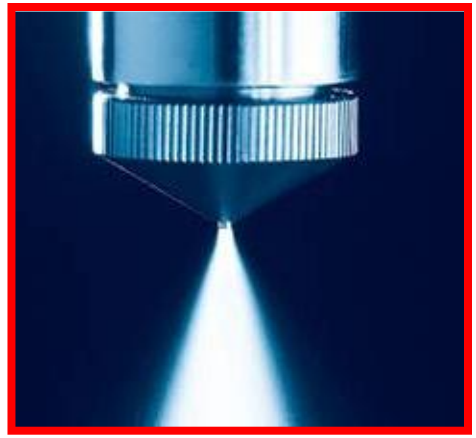
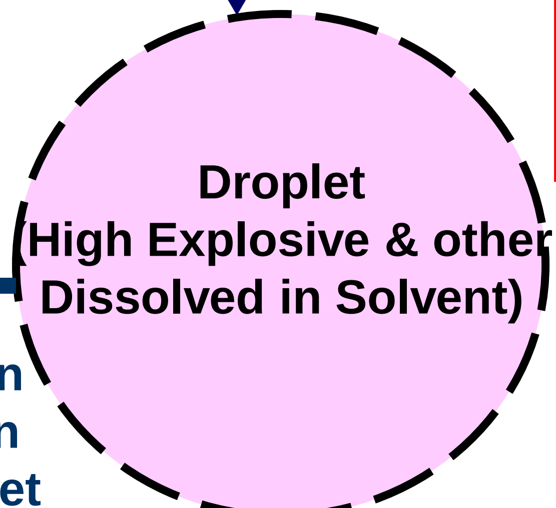
One-Step Manufacturing of Energetic Nanocomposite Granules

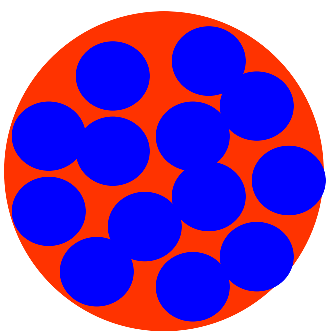


RDX/PVAc Nanocomposite Granule





Co-precipitation Confined within Shrinking Droplet



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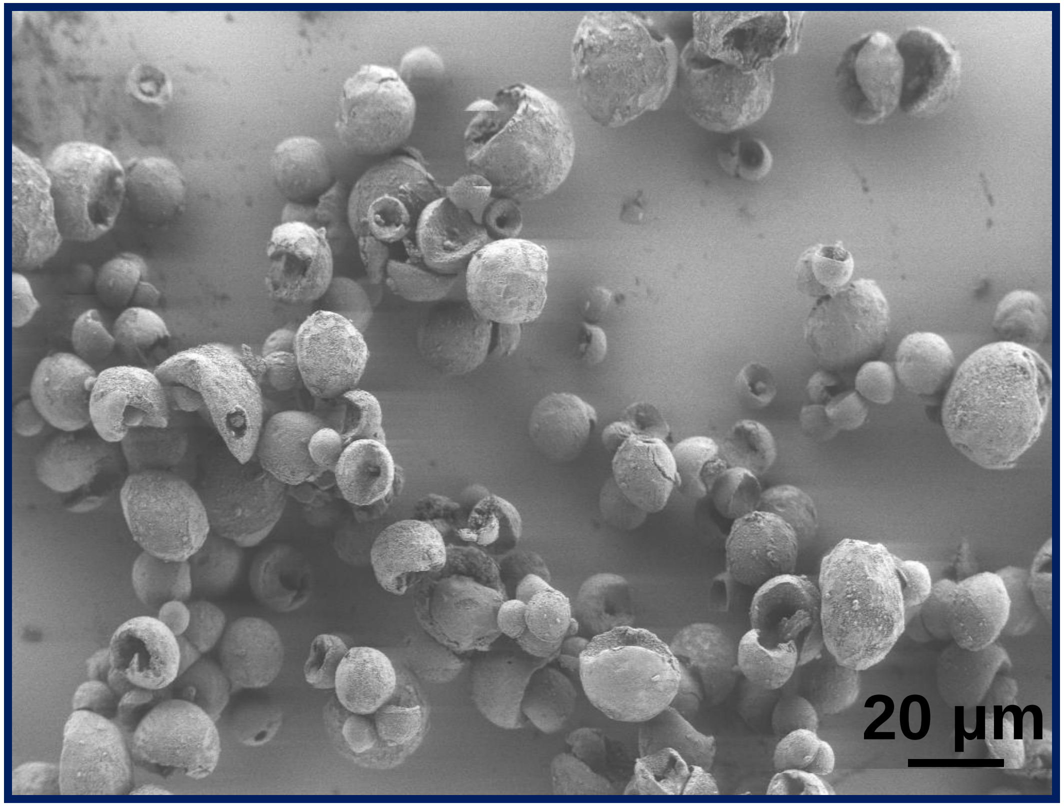
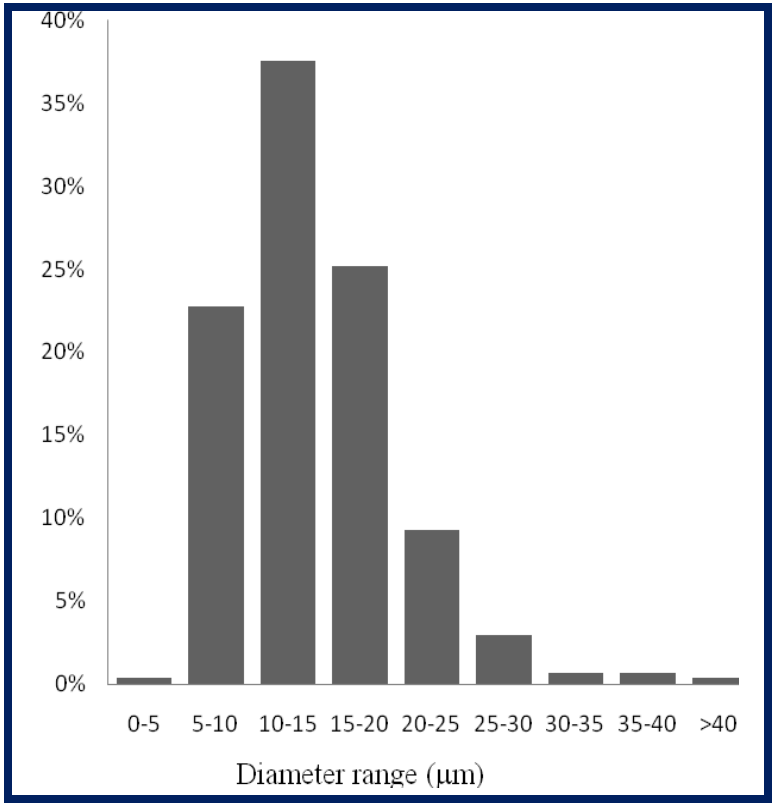
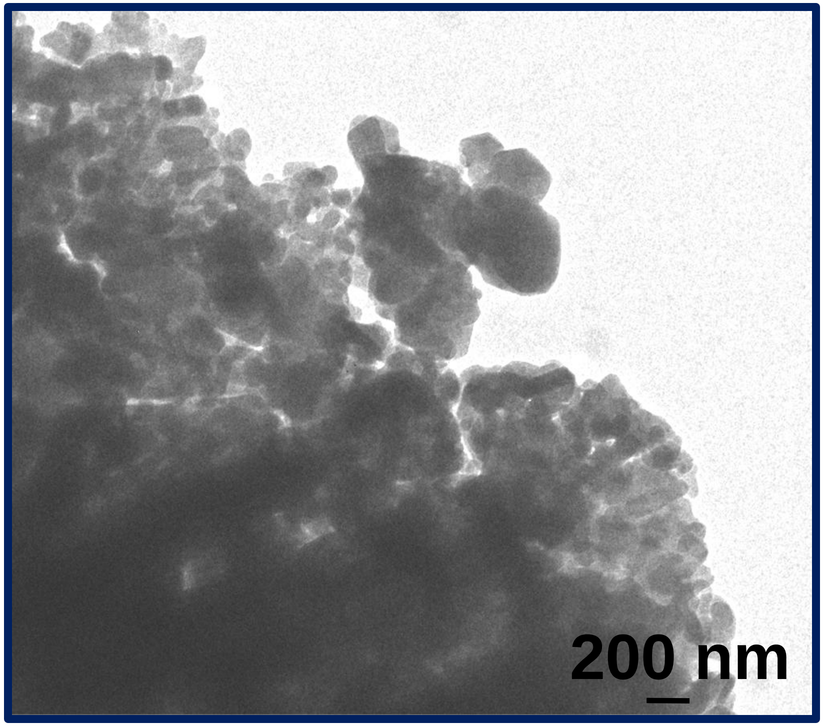
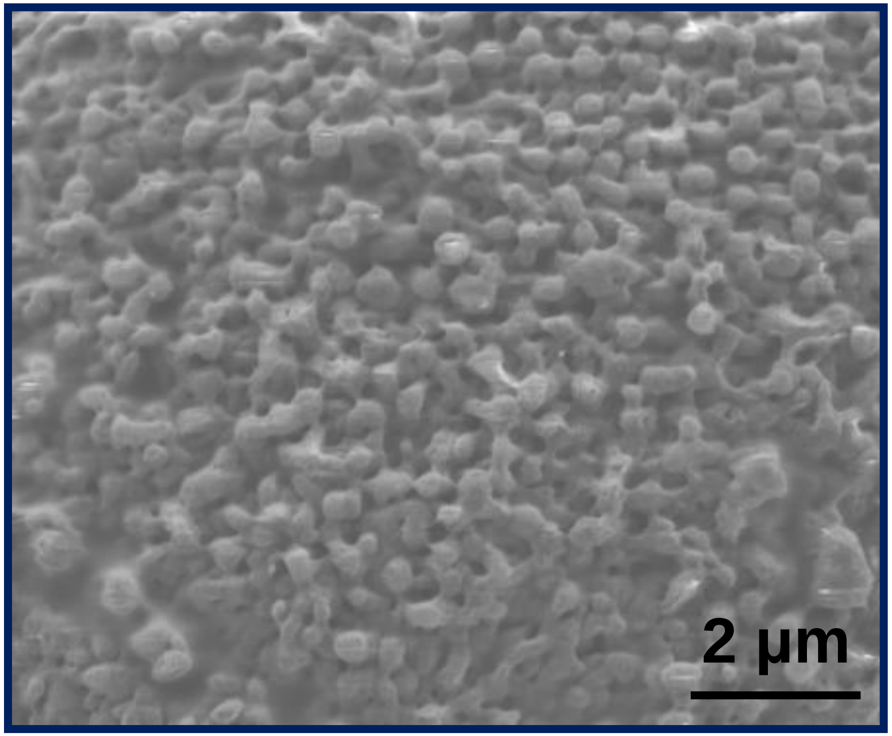
Granule Size and Size Distribution



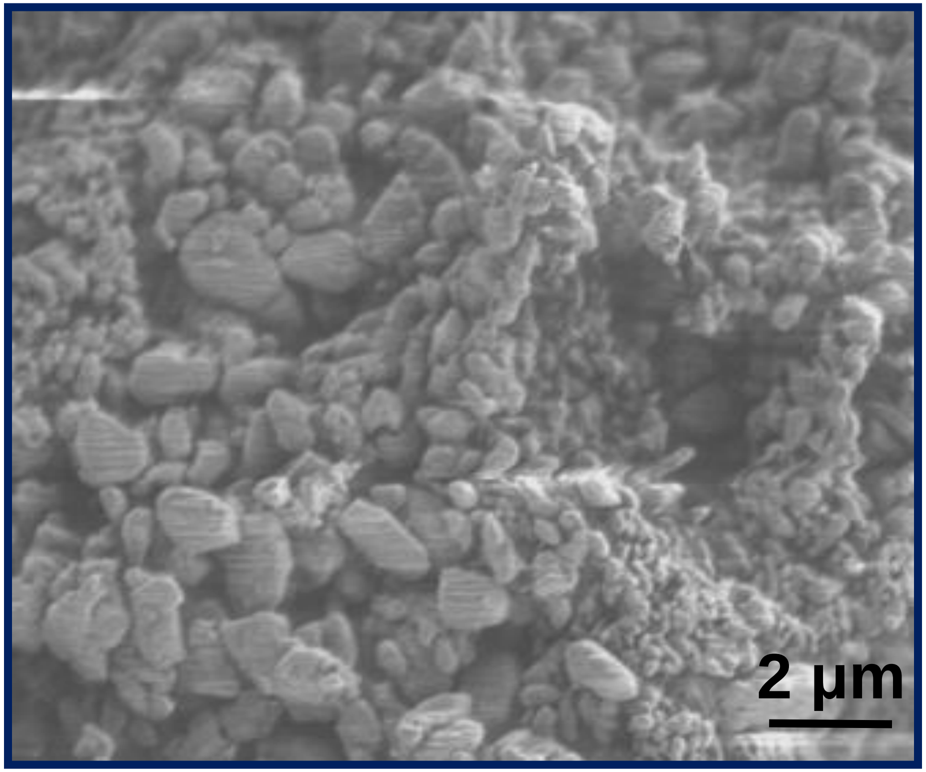


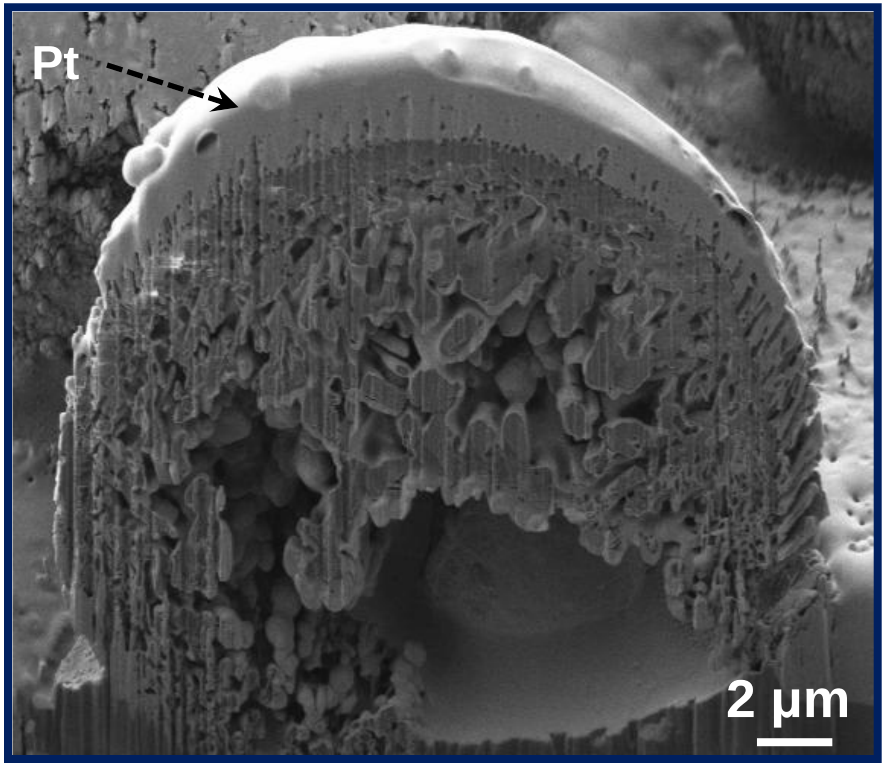
RDX Nanocrystals



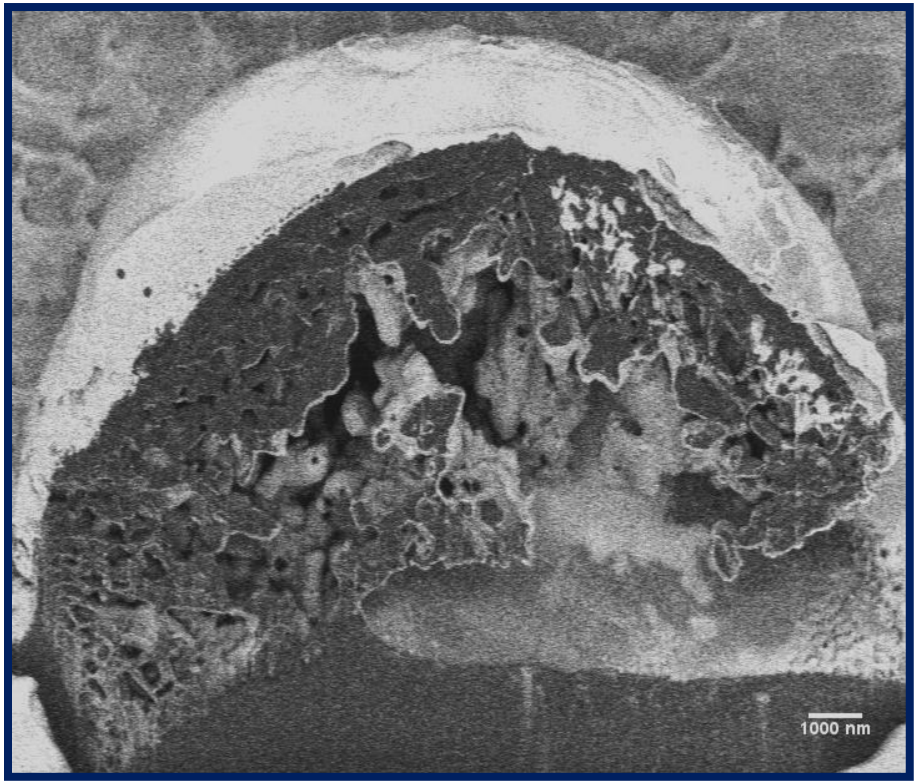


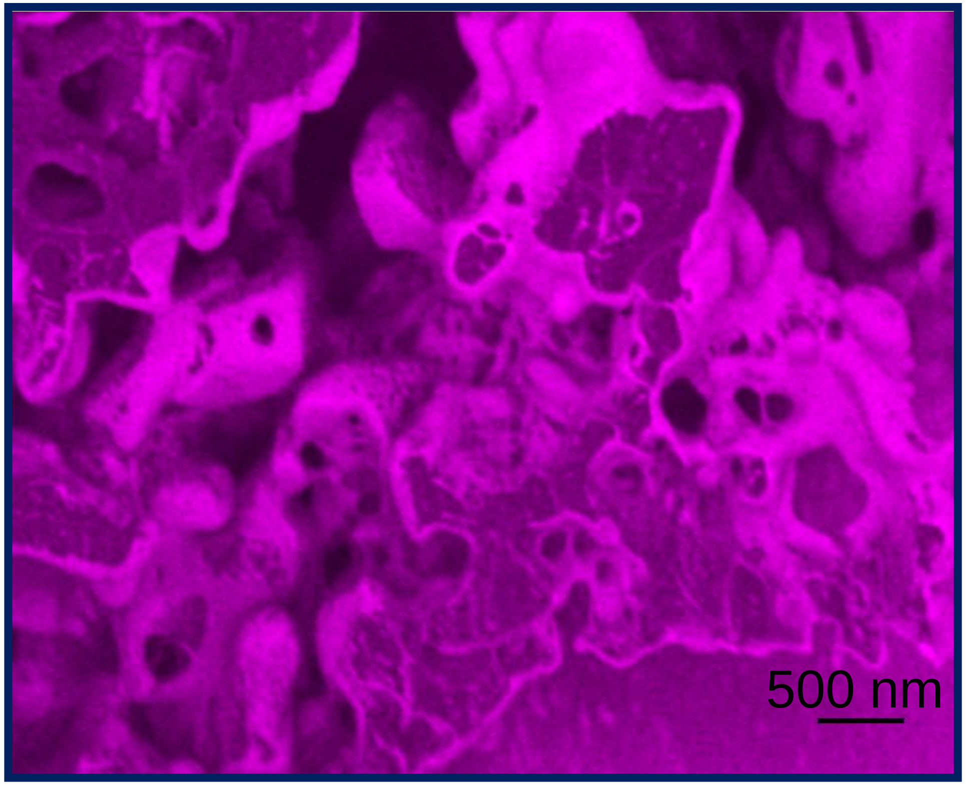
Internal RDX Crystals





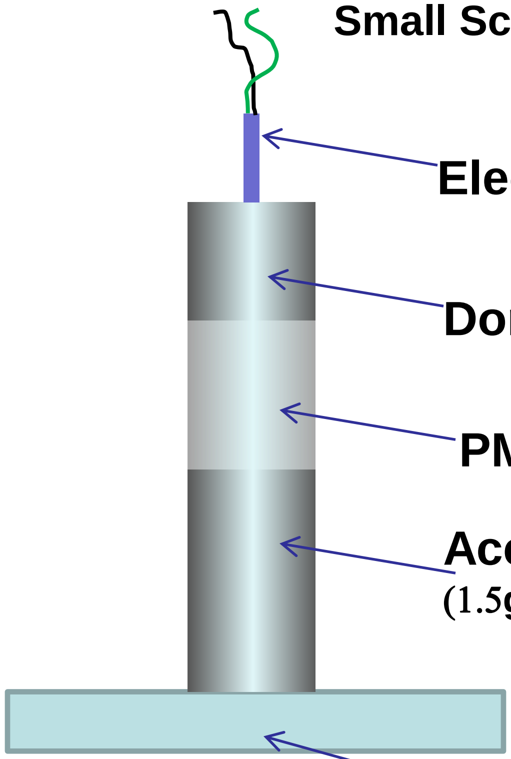
Uniform Distribution of Polymeric Binder





Shock Insensitivity Improvement

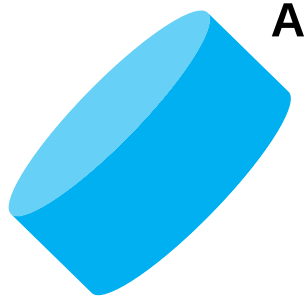
- RDX/PVAc or VMCC
  - HE: 83%
  - Avg. size: ~15 µm
- Pressing conditions:
  - 32 ksi
  - Room temperature
- Mechanism
  - Elimination of large pores due to existence of nano RDX as well as intimate nanoscale mixing between RDX and polymer

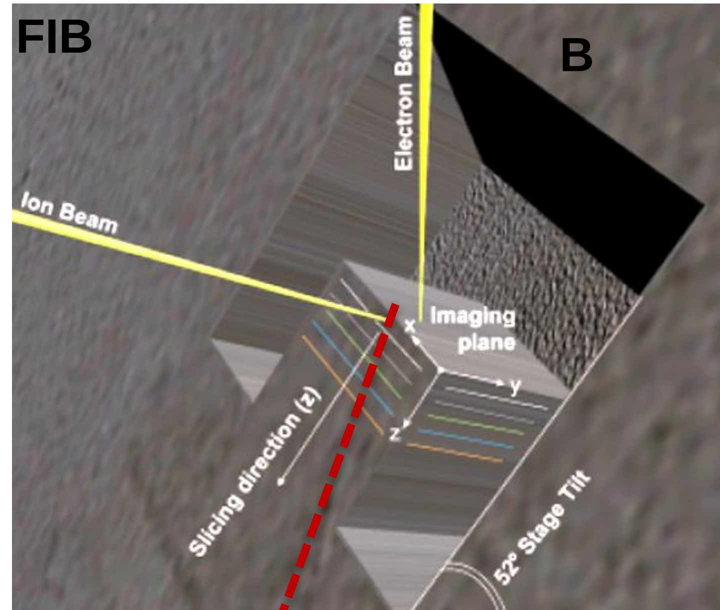


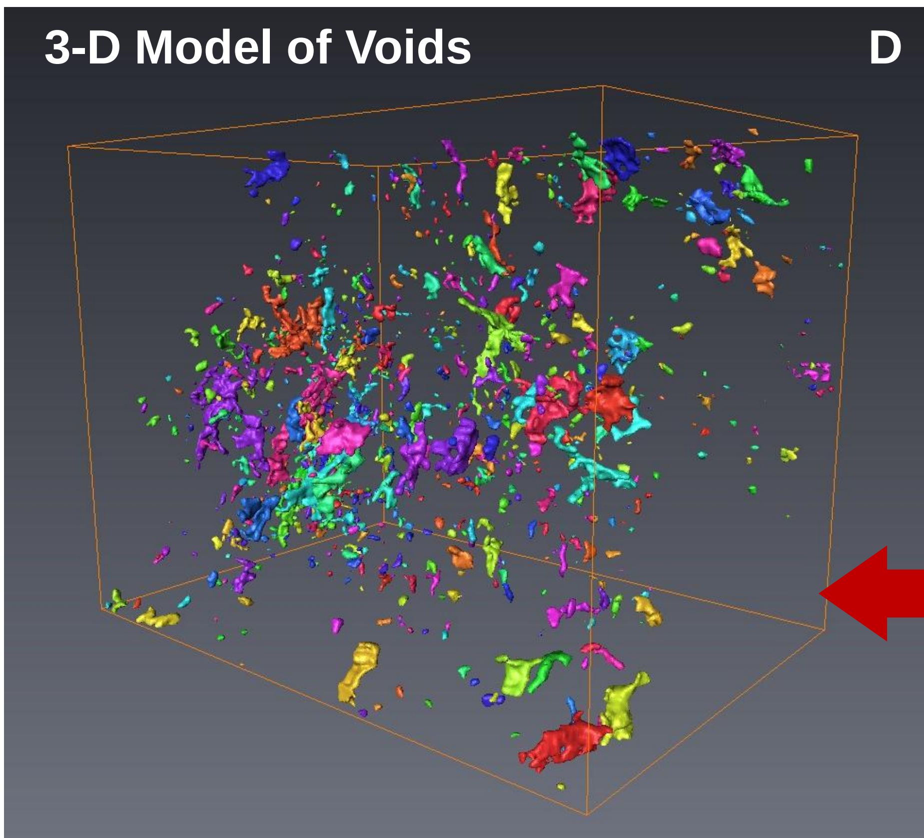
Composition	Shock Sensitivity (GPa)	Density (g/cm³)	% TMD	Binder wt. %	HMX wt.%
RDX/PVAc (Spray Dried)	4.0	1.58	91.9	17	4
RDX/VMCC (Spray Dried)	3.3	1.62	92.5	17	9
4-µm RDX/VMCC (Slurry coated)	2.5	1.64	93.7	17	9

Focused Ion Beam (FIB)-SEM Characterization of Voids

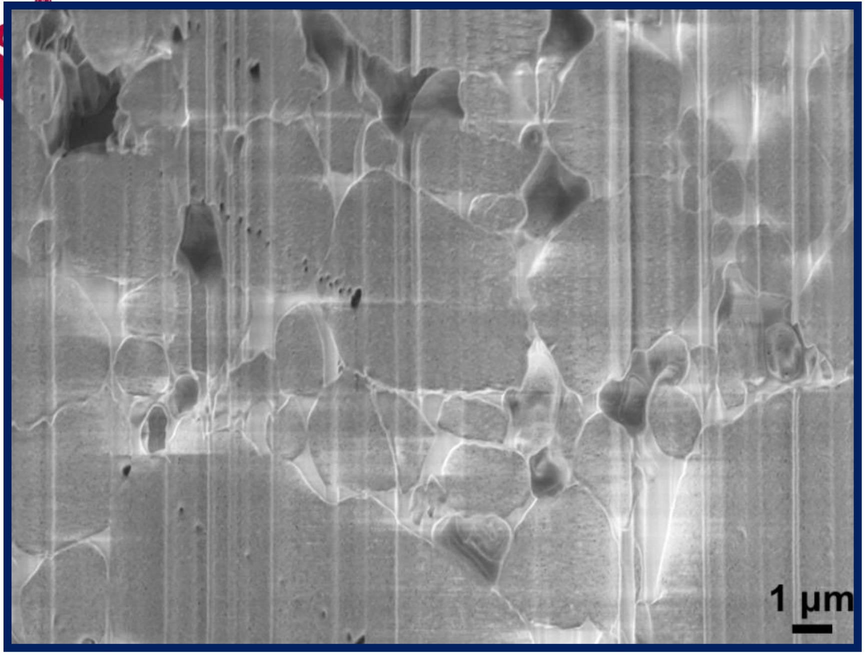
Pellet from Pressed Formulation

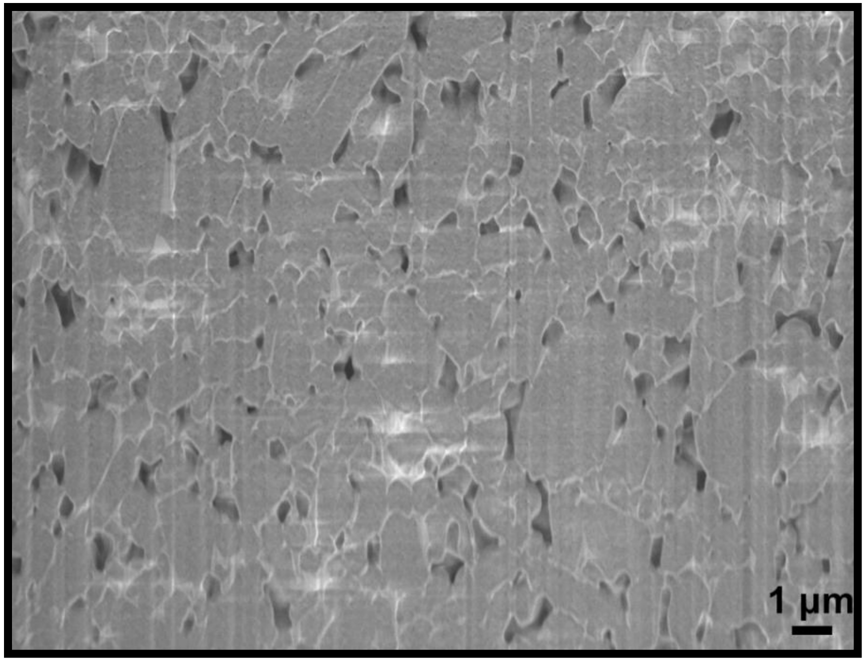


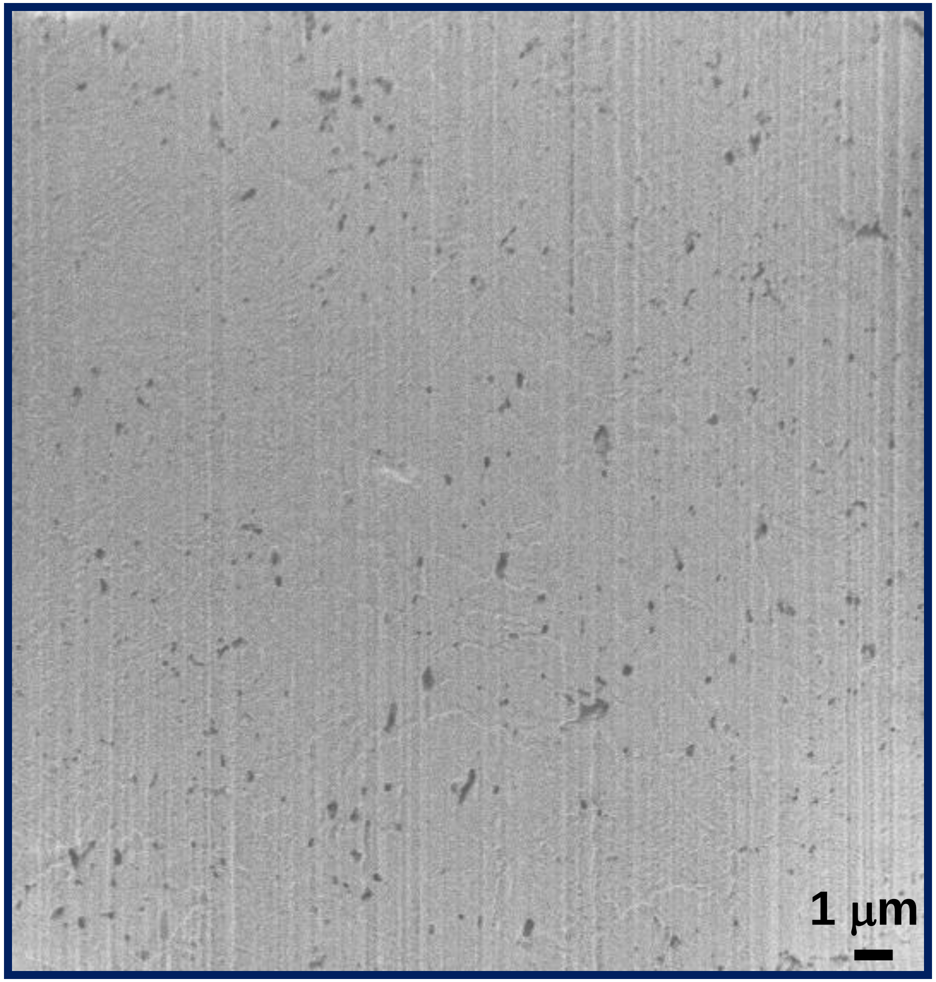




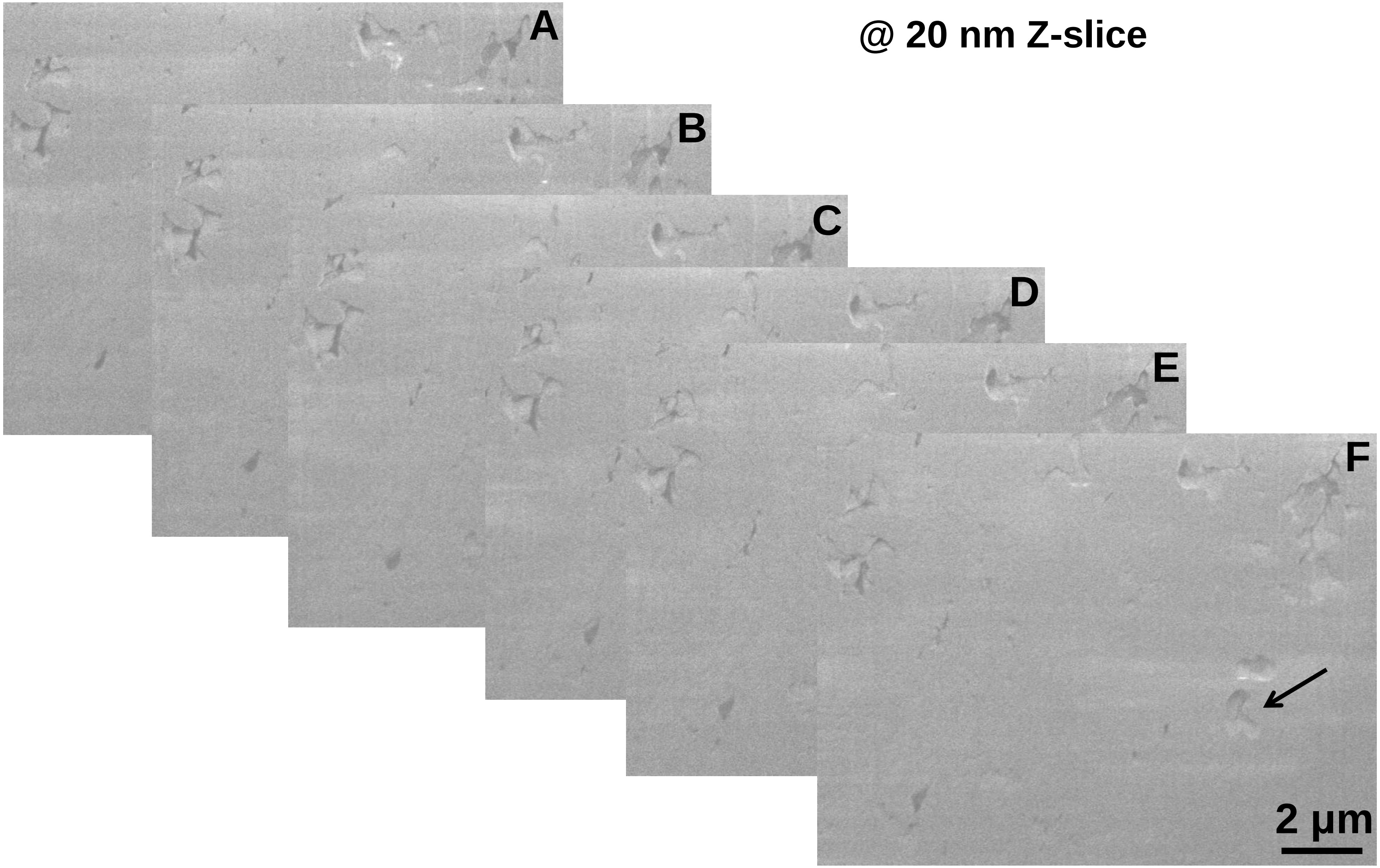
Voids in Pressed Formulations



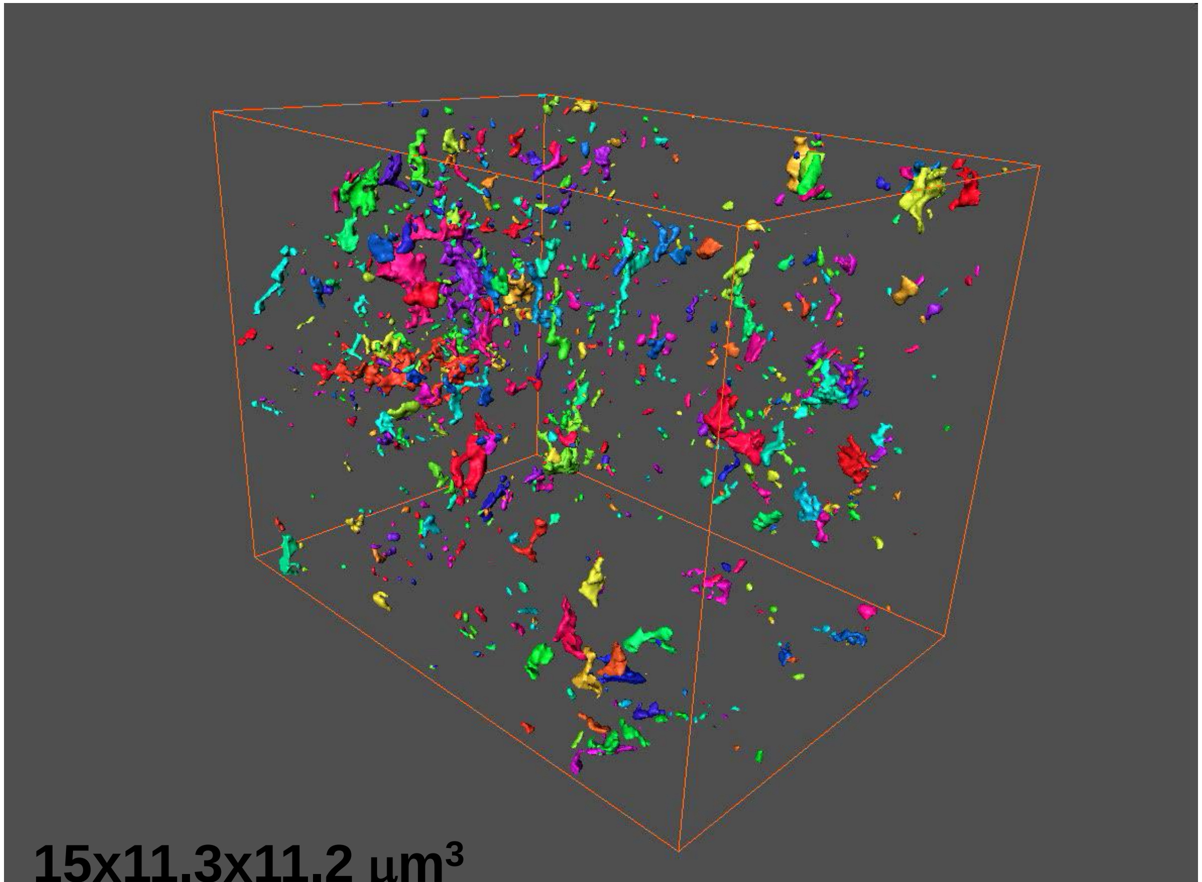




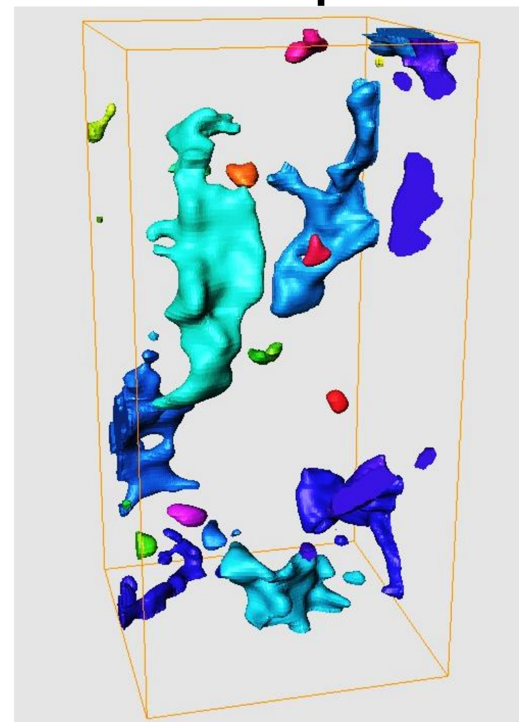
FIB Milled at -135° C



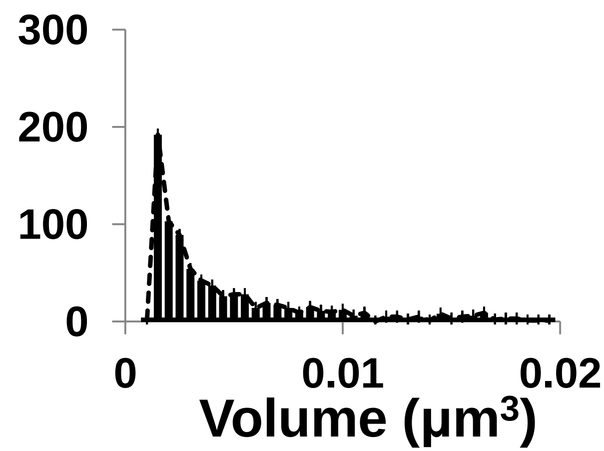
Voids Reconstruction



A close-up view



2x2 x4 μm



Voids <0.001 μm³ were filtered out
Cross-sectional images collected by FIB-SEM at -135ºC

Pressed Formulation of Nanocomposite Eliminates Large Voids

- **RDX crystals are small (sub-micron)**
  - **Small internal voids**
  - **Small external spacing**
- **RDX crystals have a size distribution which can enhance particle packing during pressing**
- **Uniform mixing between RDX crystal and binder improves the filling of empty spaces during pressing**

Conclusions

- **A one-step process was developed for manufacturing RDX nanocomposite granules. Pressed formulation of the granules demonstrated significantly reduced sensitivity in SSGT test.**

- **The voids inside the pressed formulation were characterized using FIB nanotomography. The voids have an average size of ~ 250 nm. Volume, shape, and spatial distribution of the voids were also obtained.**

- **The superior shock insensitivity is attributed to the elimination of large voids, due to small RDX crystals and uniform mixing of binder and RDX in the nanocomposite granules.**

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