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U.S. Army Research, Development
and Engineering Command



Characterization of Granular IMX-104



TECHNOLOGY DRIVEN. WARFIGHTER FOCUSED.

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- Background
- Objective
- Slurry Coating Process
- Day Zero Bulk Powder Characterization Tests
- Shock Sensitivity
- Conclusions

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Background

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- US Army transitioned M795 IM PGK compliant projectiles by providing significant improvements in accuracy in a low cost system mated to an existing, in service reduced sensitivity artillery munition.
 - Reduce ballistic delivery errors and collateral damage, < 50m CEP and improved artillery terminal effectiveness.
- Current system involves melt casting IMX-104 transfer charge into the pre-drilled extended supplemental charge cavity in the IMX-101 main charge
 - Labor and cost intensive, add-pour, re-drill and X-ray
- A New pressed IMX-104 “drop in” transfer charge will be incorporated in a current system via Material change program
 - Granular IMX-104 is being produced via slurry coating process suitable for high speed pressed booster/transfer/supplemental charge applications.
 - Energetic material and system qualification



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Objective



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- The objective of this program is to develop an slurry coating process to produce granular IMX-104 suitable for high speed press application to replace current melt casted IMX-104 transfer charge and the PBXN-9 supplemental charge in the current M795 IM PGK compatible projectiles with pressed IMX-104 transfer and supplemental charge.
- The change in the projectile configuration will be incorporated using an Engineering change proposal (ECP)
 - Granular IMX-104 energetic qualification IAW US Army energetic material qualification board.
 - PQT, SET, Proof of principle, Initiation reliability and IM tests in M795 IM PGK compatible projectiles

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Technology Description

- The granulated material was produced at BAE at pilot scale level (125 lb batch)
- The ingredients were mixed with the slurry/performance fluid to a temperature.
- The quench fluid (performance fluid) is then added to the vessel and the temperature cooled via the water jacket on the reactor
- Total of 4 pilot scale granulated IMX-104 batches with different levels of chlorez and the Indramic wax were produced at BAE.
- Agitation rate was optimized during the pilot scale runs to obtain the desired particle size.
- Down selected Granulated IMX-104 with Indramic wax
- Produced over 500 lbs of material during January 2015 for energetic qualification and the product qualification in M795 IM projectiles.



BAE-Pilot plant reactor 200 gallon

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Granulation vs Flake

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Granulated IMX-104
With Indramic wax



Flake IMX-104

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Test	Method	Granular IMX-104	Flake IMX-104
Self-heating (DSC) onset	AOP-7 202.01.020	217°C	210°C
Self-heating (DSC) Peak	AOP-7 202.01.020	257°C	224°C.
Vacuum thermal Stability	AOP-7 202.01.001	0.72ml of gas at STP	0.571ml of gas at STP
Critical temperature	AOP-7 202.01.012	137.8°C	164.33°C
Density	AOP-7, 102.01.071	1.686 g/cc	1.728 g/cc
Coefficient of thermal expansion (TMA)	Micrometer	92.28e-6/C	138e-6/C
Electrostatic Sensitivity	AOP-7 201.03.001	No reaction at 0.025 J	No reaction at 0.25 J
ERL Impact	AOP-7 201.01.001	> 100 cm	114.4 cm
BOE Impact	AOP-7 201.01.003	Reacted 0 out of 10 trials	Reacted 0 out of 10 trials
ABL friction	AOP-7 201.02.005	No reaction at 1800 lb (8000 N)	Reacted at 128 N. No reaction at 120 N
BAM friction	AOP-7 201.02.006	No reaction at 360 N	Reacted at 168.2 N. No reaction at 160 N
Woods metal bath	MIL-STD-650, 506.1	253°C	245°C
Explosivity of Dust	ASTME 1226	100-200 grams per cubic meter	600-700 grams per cubic meter
Thermal Stability test	TB 700-2, para 5-4c	Pass	Pass
Small scale burn	TB 700-2, para 5-4a	Pass	Pass
Cap sensitivity	TB 700-2, para 5-6a	Pass	Pass

Shock Sensitivity



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- Large scale gap testing (LSGT) was performed IAW AOP-7, 201.04.001.
- The granulated IMX-104 with indramic wax LSGT pellets were pressed and loaded into the 1.5-in. diameter by 5.0-in. long steel tubing that was supported by a 0.375-in. thick witness plate. A detonator sat on top of penolite booster pellets that were separated from the test sample by a series of card gaps.
- The clear cut hole on the witness plate determined whether the test was a go or no go.
- The 50% point between go and no go for granulated IMX-104 baseline ($p=1.66$) is 155 cards (36.1 kbars). For Comparison, LSGT card gap value for regular flake IMX-104 melt casted into the tubes mentioned above is 120 cards (49.6 Kbars)

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Conclusion



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- The Initial qualification test results indicate that granular IMX-104 meets and exceeds the requirements for material release qualification program and has very similar properties to flake IMX-104
 - More Energetic and material qualification tests are scheduled/ongoing. The program will provide more data to the community during the next IMEM meeting
- Ground breaking technology and very simple process to produce granular material.
 - Technology can also be applied to other high solids IM melt pout formulations to produce granular material for pressed applications
- The ingredients used in the composition are currently available in National Technology and Industrial Base (NTIB).

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Acknowledgements



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- ARDEC

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