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Shear Induced Reaction Localizations and Mechanisms of Energy Dissipation in PBX Subjected to Strong Shock[1]

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Paper addresses two emerging topics: how reaction initiation arises when PBX is subjected to shock and how detonation wave becomes oscillating. We apply the 96-channel optical analyzer for simultaneous measurements of radiation from the reaction spots surface and stress field caused by shock or detonation reaction zone in multi-layer optical monitor. This metrology allows meso-scale probing of the 3-D structure of shock- or detonation- reaction-zone as well as revealing mechanisms of its formation at different initiation scenarios. The dominant role of the shear driven plastic deformation in initiation scenario is disclosed in all tested PBX-s (including simulants of PBXN-110, PBAN-128, PBXN-109, 111, 121 and B-2208), in wide range of PBX sample sizes: from 1 mm^3 (single crystal within the binder) up to few cm^3. This research is complementing a separate, longer running, theoretical effort by Dr. Steve Coffey that examines the solid state–quantum physics responsible for initiation of explosive crystals subjected to shock or impact. Finally, this represents a novel research effort to relate plastic deformation, energy dissipation and localization in crystals to shear and shear deformation. The accompanying experimental results strongly support Coffey's theoretical prediction that initiation is due to shear driven plastic deformation and is not due solely to uniform shock pressure. Finally, we will present and discuss the recently revealed phenomenon of the thermal precursor origination caused by the reaction front radiation. The role of this earlier unknown energy localization mechanism, at Shock-to-Detonation transition in PBX, will be shown as a function of HMX particle sizes and the PBX porosity.

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