High Strain Rate Experiments of Energetic Material Binder

Roberto Rangel Mendoza, Purdue University
Michael Harr, Purdue University
Weinong Chen, Purdue University

ABSTRACT

Energetic materials, in particular HMX, is widely used in many applications as polymer bonded explosives (PBX) and rocket propellant. However, when damaged, HMX is known to be an unstable substance which renders it a hazardous material and in some cases unreliable. Finding critical mechanical conditions at high rates that render various forms of energetic materials as unreliable would be vital to understand the effects that vibrations and compression forces have on energetic materials. A better understanding would enable the ability to develop improvements in the manufacturing of PBX and rocker propellant. The method utilized to evaluate the mechanical properties of the material involved a compression Kolsky bar where a projectile hits an incident bar at 5 meters per second. The incident bar then compresses a binding polymer specimen composed of Sylgard 184 at the other end. Strain gauges were applied to the incident bar to measure voltage changes due to strain. In addition, a load cell was placed behind the specimen to measure compression force histories. The specimens studied were varied to evaluate correlation between composition and mechanical behavior. The results from the experiments showed that the binders with a lower mixing ratio of base to curing agent made the bonding polymer stiffer and less prone to elastic deformation. The results also unveiled that the stiffer binder experienced a higher compression stress due to it’s limited elastic deformation. The results also show that, at the strain rates studied, none of the binders failed. However, the measured results provide insight to manufacturers to select proper binder for specific loads. Further research of the compression force on HMX within Sylgard 184 is needed to delineate whether a stiff or ductile binder is more reliable for PBX.

KEYWORDS

Compression, Kolsky Bar, Sylgard 184, PBX