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Shock Initiation of Explosives – High Temperature Hot Spots Explained[1]

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The pore-collapse mechanism for hot spot creation is currently one of the most intensely studied subjects in the initiation of energetic materials. In the present study, we use 1.5 – 3.5 km s-1 laser-driven flyer plates to impact microgram charges of both polymer-bound and pure pentaerythritol tetranitrate (PETN) while recording the temperature and spatially-averaged emissivity with a high-speed optical pyrometer. The 32-color pyrometer has nanosecond time resolution and a high dynamic range with sensitivity to temperatures from ˜7000 to 2000 K. Hot spot temperatures of 4000 K at impact are observed in the polymer-bound explosive charges where an elastomeric binder is used to fill void spaces. In pure PETN and more heterogeneous polymer-bound charges, in which significant void space is present, hot spot temperatures of 6000 K are observed, similar to previous reports with significant porosity. We attribute these high temperatures to gas-phase products formed in-situ being compressed under the driving shock. Experiments performed under various gas environments (air, butane, etc.) showed a strong influence on observed temperature upon impact. Control experiments where the PETN in the polymer-bound charges were replaced with sucrose and silica reinforce the result that hot spots are a result of in-situ gas formation from decomposition of organic molecules.

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