

**University of Vermont
Theoretical and Applied Physics**

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**Thermal Explosions: Sub-Sonic
Deflagration in High Explosives**

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Our team has been studying the response of high explosives to abnormal thermal scenarios, often referred to as the "slow cook-off" regime, with the ultimate goal of being able to predict the reaction violence of the specific plastic-bonded explosive PBX 9501 to such an event. The primary energetic material in PBX 9501 is the organic crystal called HMX, an important military explosive and rocket propellant ingredient. HMX has proven to provide a very rich physical chemistry toolbox. Work on the kinetics of the pre-ignition thermal decomposition of HMX led to the discovery of a new mechanism for solid-solid phase transitions, which we've named the virtual melt mechanism. It is a transition between two solid crystalline phases of different symmetries, which is governed by the heat of fusion, despite the occurrence of the transition at a temperature over 100 K below the thermodynamically stable melt phase.

Our most recent advances towards an understanding of thermal explosions in PBX 9501 are based on the ability to perform high-energy radiography (such as proton and x-ray) of thermal explosion events. Radiography of super-sonic detonation events in these materials has been informing the community for over 50 years, however, radiography of sub-sonic deflagration has only recently been enabled by advances in our understanding and ability to control thermal explosion events. In the course of this work, we have developed the ability to control the ignition location and predict the time and location of ignition. We have developed several modifications to standard temperature and pressure measurements to allow us to study thermal explosions. These advances have taught us how to synchronize a thermal explosion and trigger external diagnostics early enough to use high-energy radiography such as x-ray and proton radiography in order to follow the evolution of density inside a PBX 9501 thermal explosion. I will show images of this density evolution and describe our current state of understanding and predictability for thermal explosion events.

Wednesday, November 11, 2009

4:00 p.m.

Lafayette L207

Refreshments will be provided at 3:30 PM.