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OPTICAL PYROMETRY OF FIREBALLS OF METALIZED EXPLOSIVES

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To enhance the performance of explosives, the addition of metal powders to standard HE compositions is a common alternative to developing new chemical formulations. The ability of the metal additive to react not only with the explosive products but also with surrounding air has the potential for increasing the specific energy release significantly. Conversion of this energetic potential to enhanced blast performance depends critically on the ignition and combustion dynamics of the metal particles. Due to the complex dynamics and kinetics within the fireball, direct experimental information on ignition delay times is of particular importance. The present paper presents the design and first test results using two three-color optical pyrometers which provide remote dynamic temperature measurements using continuous emission spectra from the condensed matter within the fireball. The pyrometers consist of a light-collecting optical system connected via optical fiber to an electro-optical system containing fast-response photomultipliers. Using two identical units, different dynamic ranges can be chosen to resolve both short (microseconds) and long (milliseconds) events. Light emission from both spherical and cylindrical charges has been studied. Spatial resolution of the cylindrical charges was accomplished by recording the emission through a narrow slit perpendicular to the charge. The results for homogeneous charges (TNT and nitromethane) are compared with those from heterogeneous charges consisting of packed beds of metal powders (aluminum, magnesium or zirconium) saturated with NM. The experimental results show that the moment of particle ignition does not coincide with the maximum light intensity from the fireball but generally corresponds to a “jump” in fireball temperature. The temperature of fireballs from pure NM and TNT charges are about 2000 K and remain almost constant in spite of the variations in light intensity. The color temperature of fireballs with burning metal particles exceeds 3000 K and is in general agreement with thermodynamic predictions.