The Proper Wavelength for Pyrometry on Shock Physics Experiments

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Usually one wants to measure the thermal radiance emitted by a hot surface at a wavelength as short as possible because the uncertainty in true temperature due to unknown emissivity decreases with decreasing wavelength. Unfortunately the radiance also decreases with decreasing wavelength, and hence the signal to noise ratio becomes worse with shorter wavelengths. Depending on what temperature range is to be covered, a reasonable compromise can be found in most applications. When pyrometry is applied to shock physics experiments there is an additional factor that has to be taken into consideration. Due to the nature of shock physics experiments, one has to deal with background light caused by flashes from air lighting up, high-explosive light, and muzzle flash from a powder gun, among other factors. In addition, even if the experiment is designed appropriately, there is often temperature nonuniformity caused by surface roughness due to machining or grain boundaries in metals and porosity and composition inhomogeneities in minerals and rocks. In most cases there is no engineering approach to minimize these temperature nonuniformities. The sensitivity to these nonuniformities increases with decreasing wavelength for the very same reason that the sensitivity due to uncertainties in emissivity decreases. This paper describes the above problems in detail and presents arguments for why single wavelength pyrometry in shock physics experiments can be very deceiving even in well designed experiments.