OPTICAL FIBER/SPECTROMETER MEASUREMENT OF TRANSIENT THERMAL RADIATIVE DATA IN AN OPERATING SOLID ROCKET MOTOR

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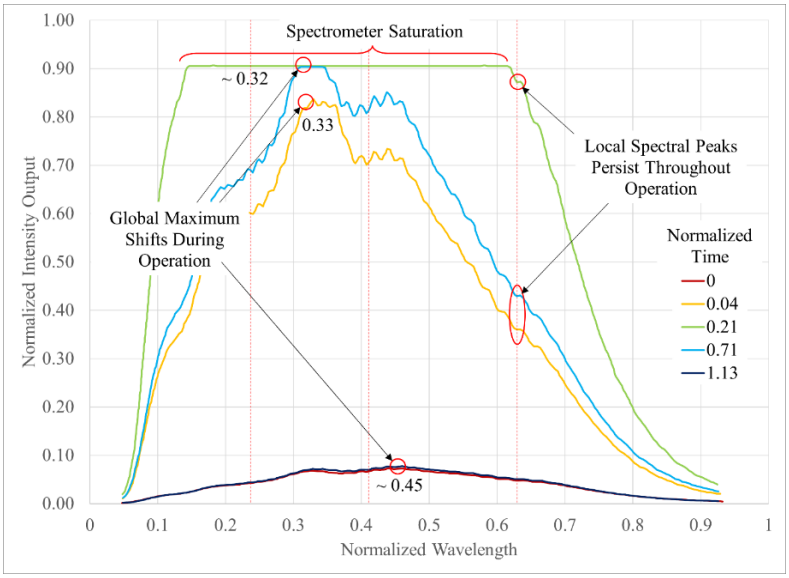
Due to the aggressive environments generated inside an operating solid rocket motor (SRM), direct measurements are extremely difficult to take [1]. The modified Gardon gauge is the only reported measurement instrument used for the characterization of thermal radiation inside an SRM, with limited success [2]. Rapid accumulation of soot on the radiation window and the relatively large size of the instrument are significant detriments to the successful measurement of transient thermal radiation throughout SRM operation. Whitmore et al. were the first to measure fully transient thermal radiation data inside an operating rocket motor throughout operation [3]. They employed an optical fiber/spectrometer technique to take these measurements in a hybrid rocket motor. To determine the feasibility of this technique in an SRM, similar experiments were conducted with a subscale motor provided by Northrop Grumman.



Spectral distributions of intensity values measured during the test are shown in the figure at various normalized times after ignition. The data show the increase in intensity spectra from ignition to midoperation, then decrease until after the end of operation. The spectra global maxima shift from a normalized wavelength of 0.45 to 0.33 within 4% of operation, decrease to below 0.32, then return to 0.45 by the end of operation, indicative of Wien's law, i.e., spectral intensity peaks are inversely related to emission temperature. This marks the first time transient thermal radiative data have been measured inside an SRM throughout operation.

[1] Davenas A. Solid rocket propulsion technology. Newnes; 2012.
[2] Christensen BY, Flight amplification in solid rocket motor forward domes: causes and recommendations. Final report for astronautics laboratory contract F04611-86: 0116.
[3] Whitmore SA, Frischkorn CI, Petersen SJ. Aerospace 2022;9:57

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