

The use of Novel Dimension Reduction Optical Fiber Arrays for Hyperspectral Imaging in Flames

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ABSTRACT

Hyperspectral imaging involves the measurement of fluorescence and emission images simultaneously in many different spectral regions. We are investigating a new approach to hyperspectral imaging that is well suited to simultaneous measurements of temperature and fluorescent species, such as OH radical, in a flame or other combustion system. In this technique the flame region of interest is imaged onto the tip of an optical fiber bundle that contains 500-600 fibers. The image is then transformed at the other end into a linear array and is re-imaged onto the vertical slit of a high-resolution spectrograph. The light from each fiber in the array is spectrally dispersed and all fiber spectra are simultaneously measured using an intensified CCD. Spectral images are then reconstructed at any wavelength, or combination of wavelengths, to show the distribution of temperature or species concentrations in the flame. It is shown that a single measurement of this type, can yield data on the two-dimensional distribution of temperature and the relative concentration distribution of a variety of species in a flame. The spatial resolution using this technique is limited by the number of fibers in the array, and ultimately by the height of the intensified CCD. In this paper, we show feasibility by measuring flame temperature and emission of reference species. We propose to use this technique to measure the effect of flame retardant chemicals on energetic radical flame species. In a related study, we are investigating laser ablation to introduce controlled amounts of flame retardant chemicals into a flame.