INFRARED SPECTROSCOPIC STUDIES OF WIND-TUNNEL CONTAMINATION

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Three infrared diagnostic techniques are developed to characterize chemical contamination in wind tunnels and shock tubes which can affect the reliability of infrared sensor and imaging system tests. The techniques are based on mid-infrared spectroscopy, since the primary interest is in contaminants with mid-infrared emission or absorption spectra overlapping spectral windows of HgCdTe and InSb-based detectors. The first technique consists of collecting a sample of the pre-expansion wind-tunnel or shock-tube feedstock gas stream and then analyzing the sample with long-optical-pathlength, high-spectral-resolution, Fourier-transform infrared (FTIR) spectroscopy. The technique has the capability of giving a broad survey of potential chemical contaminates in the flow stream, but suffers from the inability to characterize contaminates which form during the blow-down process. The second technique captures a sample of the wind-tunnel or shock-tube blow-down gas stream for analysis by FTIR spectroscopy. This technique gives more detailed information about the contamination than the presampling technique, but does not have the ability to detect highly reactive or unstable contaminants. Also, little information is obtained about the temporal profile of the contaminants during the blow-down process. The third technique uses a rapid-scan mid-infrared diode-laser spectrometer to record the in situ mid-infrared absorption spectrum of a specific chemical contaminant in the wind tunnel or shock tube. In its present configuration, the diode-laser spectrometer has a time resolution of approximately 100 ms. The three techniques are demonstrated using the Mach 8 wind-tunnel facility at Princeton University and the Hypervelocity Wind Tunnel 9 Facility at White Oaks, Maryland.