WAVEGUIDE CHIRPED-PULSE FOURIER TRANSFORM MICROWAVE SPECTROSCOPY

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We have extended the broadband chirped-pulse Fourier transform microwave (CP-FTMW) spectroscopy technique to room-temperature measurements in a WRD750 double-ridge waveguide cell. To achieve high-sensitivity in room-temperature waveguide measurements it is critical to achieve high spectrum acquisition rates. In this first implementation of waveguide CP-FTMW spectroscopy there are technical limitations imposed by the data processing speed of the current generation of high-speed digital oscilloscopes. We have constructed a spectrometer that can acquire the rotational spectrum over two 4.5 GHz spectral windows: 9 - 13.5 GHz and 13.5 - 18 GHz. High-fidelity chirped pulses are required to avoid problems with slow group velocity near the low-frequency cutoff of the waveguide. We use a two-channel, 10 Gs/s (10 Gigasamples/s) arbitrary waveform generator to create the chirped pulse in each arm of the pulse generation circuit. Following pulse combination in a Wilkinson power divider the chirped pulses are amplified by a TTL-controlled solid state amplifier with 1W peak power. The subsequent molecular emission is amplified by using a broadband solid-state low-noise amplifier. The amplified signal is sent to a diplexing circuit that separates the emission signals back into the 9 - 13.5 GHz and 13.5 - 18 GHz bands. These signals are down converted to the DC - 5 GHz range and digitized at 10 Gs/s on separate channels of an 8-bit digital oscilloscope. Diplexing the signal permits the use of lower digitization rates and speeds up the overall repetition rate of the measurement. For a 4.5 GHz bandwidth measurement we achieve a repetition rate of 330 Hz. The current state-of-the-art digital oscilloscope offers improved data processing speeds and can achieve a 1 kHz repetition rate. Performance of the spectrometer is illustrated with measurements on OCS, trifluoropropyne, and acetone. The use of a joint time-frequency analysis of the broadband emission will be demonstrated that makes it possible to simultaneously measure the collisional relaxation rates for all observed rotational transitions in the time domain. Prospects for performing selective-excitation double-resonance measurements to aid the spectral assignment of complex, room-temperature spectra will be discussed.