HIGH RESOLUTION INFRARED SPECTRA OF PLASMA JET-COOLED DI- AND TRIACETYLENE IN THE C-H STRETCH REGION BY CW CAVITY RING-DOWN SPECTROSCOPY

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Polyacetylenes form an important series of unsaturated hydrocarbons that are of astrophysical interest. Small polyacetylenes have been detected from infrared observations in dense atmosphere of Titan and in a protoplanetary nebula CRL 618. We present here high-resolution mid-infrared spectra of diacetylene (HC_4H) and triacetylene (HC_6H) that are recorded in a supersonically expanded pulsed planar plasma using an ultra-sensitive detection technique. This method uses an all fiber-laser-based optical parametric oscillator (OPO), in combination with continuous wave cavity ring-down spectroscopy (cw-CRDS) as a direct absorption detection tool[a]. A hardware-based multi-trigger concept is developed to apply cw-CRDS to pulsed plasmas.

Vibrationally hot but rotationally cold HC_4H and HC_6H are produced by discharging a C_2H_2/He/Ar gas mixture which is supersonically expanded into a vacuum chamber through a slit discharge nozzle. Experimental spectra are recorded at a resolution of $\sim$100 MHz in the 3305-3340 cm^{-1} region, which is characteristic of the C-H stretch vibrations of HC_4H and HC_6H. Jet-cooling in our experiment reduces the rotational temperature of both HC_4H and HC_6H to $<$20 K. In total, $\sim$2000 lines are measured. More than fourteen (vibrationally hot) bands for HC_4H and four bands for HC_6H are assigned based on Loomis-Wood diagrams, and nearly half of these bands are analyzed for the first time. For both molecules improved and new molecular constants of a series of vibrational levels are presented. The accurate molecular data reported here, particularly those for low-lying (bending) vibrational levels may be used to interpret the ro-vibrational transitions in the FIR and submillimeter/THz region.

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