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Development of a sensitive photoionization mass spectrometry apparatus for high-pressure gas-phase reactions

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Synchrotron-based tunable VUV photoionization mass spectrometry (PIMS) is a powerful analytical technique for nearly universal, sensitive, isomer-selective detection of chemical species. VUV-PIMS is routinely used to probe complex gas-phase and multiphase processes in a variety of sources such as flames, flow reactors, pyrolysis nozzles, and catalytic reactors. However, it has seen limited application to studies of chemistry at elevated pressures. The main reason for this is a fundamental limitation to the sensitivity of VUV-PIMS, associated with sampling from high-pressure environments.
In this talk I will describe a new, highly sensitive PIMS apparatus, coupled to a high-pressure laser photolysis reactor, operating at P = 0.3 –100 bar and T = 300 –1000 K. The mass spectrometer uses ionization in the high-density region of the sampling expansion, followed by custom ion optics that simultaneously achieve high mass resolution and high ion collection efficiency, while avoiding ion-molecule collisions. I will demonstrate the utility of the new approach using several examples of the detection of key products and intermediates in pressure-dependent reactions: C_2H_5 + O_2, OH + CH_3O_2, and the low-temperature combustion of tetrahydrofuran.

Summary

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