Contribution ID: **30** Type: **Talk**

Diagnostic issues for clean(er) combustion

Tuesday, 30 September 2014 14:00 (25 minutes)

The transition towards renewable and sustainable energy is thought to phase out combustion. With growing population, industrial production and transportation especially in emerging economies, and with substantial life spans of current technology, this transition will, however, take decades. Cleaner combustion with higher efficiency and reduced emissions must thus be addressed with urgency.
Understanding the reaction pathways that lead to undesired combustion emissions is therefore an important issue. Reliable and predictive combustion models for conventional and alternative fuels are being be developed that can be reduced for application in practical combustion systems; they must be validated with information from defined laboratory combustion conditions, using e.g. shock tubes, flow and jet-stirred reactors and flames of different configurations.
To analyze the combustion chemistry in flames and reactors in collaboration with international partners, we have relied on a unique combination of sensitive laser-based diagnostics and advanced molecular-beam mass spectrometry. Mass spectrometric instruments using electron ionization and isomer-selective photoionization with radiation from the synchrotron sources in Berkeley, USA, and Hefei, China, have been used, as well as gas chromatography, to highlight reaction pathways for selected fuels, including hydrocarbons, alcohols, esters, furanic compounds and small amines. Most of these experimental investigations have been accompanied by detailed kinetic modeling. Recently, photoelectron photoion coincidence spectroscopy (PEPICO) performed at SOLEIL, France, has been added to this pool of methods. Examples from this collaborative research will be given with a focus on open questions and research opportunities.

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Session Classification: Session 4 Coincidence Spectrometry (Gerber)