Raman spectroscopy: a powerful tool in investigations of soot properties and soot formation processes

Abstract

Soot is any black, blackish or brown aggregate which mainly consists of carbon with a variety of bonding structures and is generated by incomplete combustion.

Every year, an amount of 10^7 tons of soot is produced on the world scale. Soot, as part of atmospheric black carbon, has serious impacts on climate change and human health. The impacts depend on many factors including adsorbed compounds, aging and mixing processes. Therefore in order to reduce the soot amount, besides considering these mentioned factors, the study of formation kinetics, structure and optical properties is also essential. There are several methods applied in soot investigations. Raman spectroscopy plays a particular role as it is a powerful tool for structural investigation of the carbon-based materials because it is sensitive to molecular structures. In this presentation, spectral properties of soot particles produced by premixed ethylene flames at a low pressure were investigated by ex-situ Raman measurement on deposited films and in-situ Raman measurement in the gas phase. Combination of the Raman spectroscopy of soot sampled on substrates with infrared and optical spectroscopy and transmission electron microscopy allowed progressing on the interpretation of soot Raman spectra. The in-situ gas phase measurements provided a novel view on soot birth and structures in low pressure flames with, for instance, the detection of a large amount of sp hybrized carbon atoms during nascent soot growth. These studies pave the way to soot detection and analysis directly and quantitatively in the atmosphere. This talk also provides a brief introduction of our current studies on the structure of soot core as well as its coating via its fluorescence and Raman signals evolution during heating processes.

Key words: Soot, black carbon, Raman spectroscopy, gas phase, low pressure flame