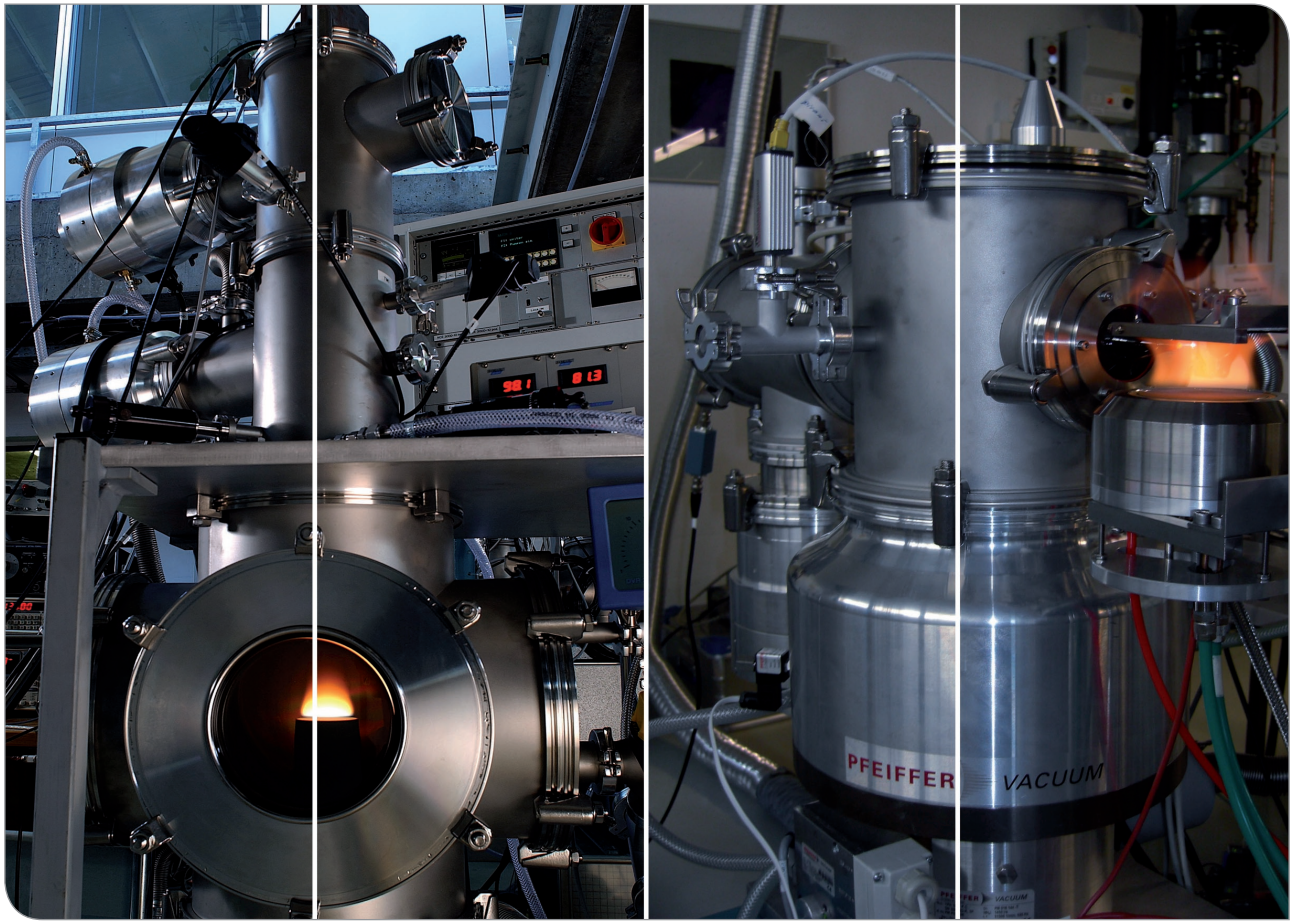
Karlsruhe Institute of Technology

Institute for Technical Chemistry

PMS – Particle Mass Spectrometer for Airborne Particles in Flames and Plasmas



Particle mass spectrometer for soot measurement in a low pressure flame.

Particle mass spectrometer for soot measurement in an atmospheric flame.

Particle Mass Spectrometer

The particle mass spectrometer (PMS) is a novel online measurement system for high concentrations of charged nanoparticles in flames, plasmas and other aerosol systems. It measures size distributions in atmospheric and low pressure applications from 1 nm to 30 nm, at high particle number concentrations which goes beyond the present state of the art. Due to its compact design, the PMS is a robust and mobile instrument that can be adapted readily to various types of particle reactors in research and industry.

Applications

- Size analysis of nanoparticles generated by gas phase synthesis
- Size analysis of soot particles in flames
- Size analysis of primary particles of combustion processes

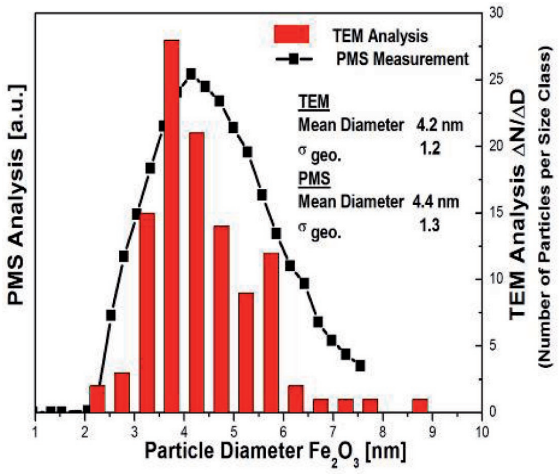
Functional description

The particle mass spectrometer (PMS) has a two stage molecular beam sampling system which transfers the sampled particles rapidly into a low pressure environment around 10^{-5} mbar. The particles pass a capacitor, where the charged particles are deflected from the straight path line according to the ratio of their kinetic energy to their charge number ($U \sim \frac{1}{2} mv^2/z$). The deflected particles are collected at faraday cups and the particle velocity is measured simultaneously with the recorded current.
The current is proportional to the particle concentration in front of the inlet. By scanning the voltage applied at the capacitor, different mass fractions reach the detector and with the knowledge of the material density, the measured mass spectrum (m/z) can be converted into a size spectrum. If the particles carry multiple charges, two or more peaks are observed in the m/z spectrum.

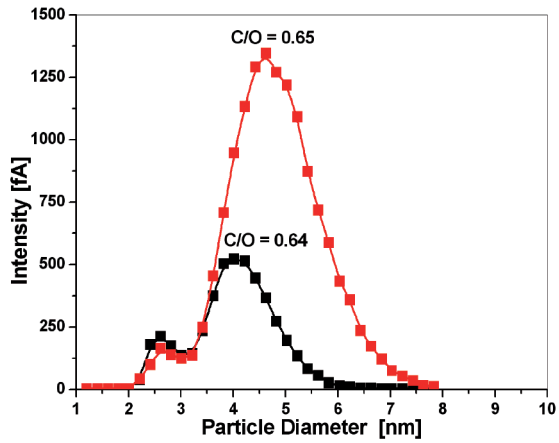
Specifications

Measurement range:	1–30 nm
Measurement time for full range scan:	1–5 min
Detection limit:	1 femtoampere [fA] or 6500 charges/s
Concentration:	$>10^9$ particles/cm³
Resolution:	2–5% of particle diameter

Results



Size distribution of iron oxide particles generated by microwave plasma synthesis.



Size distribution of soot particles in an atmospheric ethylene/air flame.

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