On recent progress in diagnostics of technological plasmas: From low to atmospheric pressure applications

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Since low and atmospheric pressure plasmas with atomic and molecular feed gases are used in an increasing variety of applications, such as thin film deposition, semiconductor processing, surface activation and cleaning, including biology and medicine, and for materials and waste treatment, this has stimulated the adaptation and development of appropriate diagnostics techniques.

The present contribution is intended as a review aimed at compiling achievements and modern trends specifically in the rapidly changing field of plasma spectroscopy and related optical techniques. Special attention is devoted to *in-situ* studies of plasma chemistry and reaction kinetics in gas discharges and on selected aspects of plasma surface interactions including applied approaches, as e.g. in plasma medicine. A link is thereby provided to modelling of plasmas and surface phenomena.

Over the last two decades chemical sensing using mid-infrared laser absorption spectroscopy (MIR-LAS) in the molecular fingerprint region from 3 to 20 µm, which contains strong ro-vibrational absorption features of a large variety of gaseous species, has been established as a powerful *in-situ* diagnostic tool for technological plasmas. Since kinetic processes are inherent to discharges ignited in atomic and molecular gases, high time-resolution on sub-second timescales is frequently desired for fundamental studies as well as for process monitoring in applied research and industry. In addition to high sensitivity and good temporal resolution the capacity for broad spectral coverage enabling multi-component detection encompassing plasma species with broader absorption structures is further expanding the use of MIR-LAS techniques.

Further, a new approach using the high time resolution and sensitivity of an optical ICCD method and of CCS (Cross-Correlation-Spectroscopy) to study a self-pulsing spark discharge operating in argon will be presented. This example shows the complexity of the spatio-temporal development of the plasma that needs to be controlled for sensitive applications especially in plasma medicine.
Modern trends in the design and applications of atmospheric pressure plasmas will be discussed.