The dielectric barrier discharge combined with diode laser atomic absorption spectrometry: A detector for gas chromatography

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Abstract

Diode laser atomic absorption spectroscopy measurements monitoring the Cl 837 nm absorption line in the dielectric barrier discharge (DBD) result in detection limits of 400 ppt CCl_2F_2 in helium and 5 ppb in argon, respectively. These values are comparable with those obtained in traditional larger plasma sources, even the average power consumption of the DBD is less than 1 Watt. The low average gas temperature and the absence of sputtering leads to a lifetime of more than 500 h for the plasma chip.

DLAAS measurements were also performed to determine the plasma parameters spatially and temporally resolved. It could be shown for an argon plasma, that the electron density in a small volume, close to the temporary cathode, reaches 10^{15} cm^{-3} and the gas temperature 1000 K, while in other areas and between the discharge cycles the electron density cannot be measured taking into account the experimental uncertainty. The gas temperature derived from the Doppler line widths is close to room temperature.

The high concentration of power density (about 0.1 kW/cm^3) in a small constricted volume makes the dielectric barrier discharge suitable for the coupling with a gas chromatograph. Therefore the capability of the dielectric barrier discharge as an element-selective diode laser absorption detector for gas chromatography is investigated. Detection limits of halogenated and sulfured hydrocarbons from the low to the high pg/s-range were obtained, depending on the element measured. Furthermore, the effect of doping gas (oxygen) and make-up gas (argon, helium) on the chromatograms was studied.