A Microplasma for Diode Laser AAS

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The application fields, process and quality analysis in industry, environmental control and the booming field of biotechnology and biomedicine require robust analytical instruments with low detection limits for the species of interest. Furthermore, the instruments have to be very small since they have to be operated outside of laboratories.

In the last 25 years, plasmas, such as the inductively-coupled (ICP) or the microwave induced plasma (MIP) coupled with the optical or mass spectrometry, became important tools for element analysis. In the application fields mentioned above, they are used to dissociate and atomize molecular species after separation, e.g. by chromatography or electrophoresis.

Down scaling of established plasmas or development of new ones which can be integrated in analytical instruments on chips is a challenging task. The properties of a dielectric barrier discharge for chemical analysis will be discussed. The dielectric barrier discharge plasma is presented as a powerful microchip source for analytical spectrometry. The dielectric barrier discharge is characterized by small size, low electric power (< 1 Watt), low gas temperature (about 600 K) and excellent dissociation capability for molecular species, such as CCl_2F_2, $CClF_3$ and $CHClF_2$. Time dependent and spatially resolved measurements show the development of the gas temperature and the electron density in connection with the dissociation of molecular species. The dielectric barrier discharge has been used here in plasma modulation diode laser absorption spectrometry of excited chlorine and fluorine in noble gases as well as in air/noble gas mixtures. The analytical figures of merit of diode laser absorption spectrometry obtained with the dielectric barrier discharge are comparable with the results found earlier with dc and microwave induced plasmas of larger size and much higher plasma powers. Detection limits of plasma modulation diode laser absorption spectrometry of 400 ppt and 2 ppb for CCl_2F_2 in He were found using the Cl 837 nm and the F 685 nm line, respectively. First measurements with a preseparation by a gas chromatograph will be presented.