Online laser monitoring of metal chloride and oxygen concentration using collinear photofragmentation and atomic absorption spectroscopy

Viljanen J, Sorvajärvi T, Toivonen J

Tampere University of Technology, Laboratory of Photonics,
P.O. Box 692, FI-33101 Tampere, Finland

Collinear photofragmentation and atomic absorption spectroscopy (CPFAAS) is a recently developed optical method for analysing molecular concentrations and their kinetics. [1,2] The technique is based on the fragmentation of a precursor molecule and the detection of the fragment atoms via absorption spectroscopy on a common laser beam path. It has been applied to monitor concentrations of the precursors KCl and KOH in thermal conversion applications. CPFAAS studies have focused on precursor molecule concentration analysis using the maximum absorbance right after the photofragmentation. Sample lengths ranging from 1 cm to 10 m have been demonstrated in the studies [2,3]. In this work, an overview and recent development of CPFAAS is presented.

Typical CPFAAS measurement arrangement is shown in Fig 1. CPFAAS technique has been demonstrated for online monitoring of KCl, KOH, and O_2 in a single particle reactor [2,3] and for KCl and $PbCl_2$ in full-scale power plant. Typical molecular detection limits reach sub-ppm levels. The spatial resolution of the measurement can be adjusted by tuning the overlapping of the fragmenting and probing laser beams. This allows collection of localized information that is often required to support modelling work of flames and combustion processes. Online measurement of $PbCl_2$ is a powerful demonstration of the CPFAAS technique's ability to be applied also to monitoring of more complex molecules, such as $ZnCl_2$, that are present in combustion processes. In addition, recent development in laser sources has brought NaCl and NaOH monitoring closer to realization.

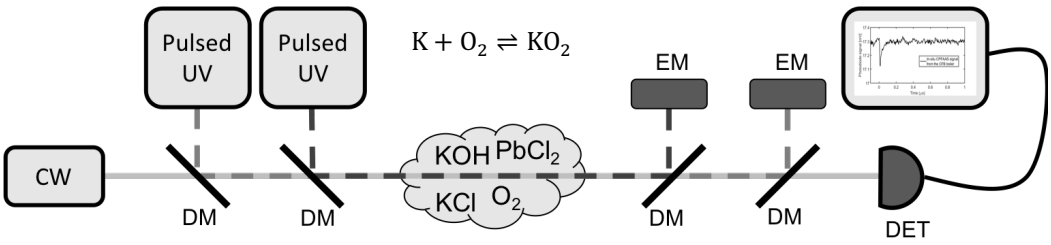

Figure 1. Schematic presentation of typical CPFAAS measurement arrangement showing the laser beam path.

References

[1] T. Sorvajärvi, et al., *Rate Constant and Thermochemistry for K + O_2 + N_2 = KO_2 + N_2*, The Journal of Physical Chemistry A **119**, 3329-3336 (2015).
[2] T. Sorvajärvi, N. DeMartini, J. Rossi, and J. Toivonen, *In situ measurement technique for simultaneous detection of K, KCl, and KOH vapors released during combustion of solid biomass fuel in a single particle reactor*, Applied Spectroscopy **68**, 179-184 (2014).
[3] J. Viljanen, T. Sorvajärvi, and J. Toivonen, *In situ laser measurement of oxygen concentratioand flue gas temperature utilizing chemical reaction kinetics*, Optics letters **42**, 4925-4928 (2017).