Abstract

The thesis focuses on the detection of chemical substances using ion mobility spectrometry (IMS) with a corona discharge as the ionization source. In various experiments, IMS was also combined with time-of-flight mass spectrometry (ToF-MS) and laser desorption (LD) sampling to expand analytical capabilities and improve the identification of target compounds.

The first part of the results is dedicated to the study of chemical ionization of NO_2 via $O_2^- \cdot CO_2$ ions in the IMS reaction chamber. Kinetic parameters of the ion–molecule reaction were determined, including the rate constant of electron transfer, a calibration curve for NO_2 detection, and the corresponding limit of detection. These results were subsequently applied to the characterization of species generated by an atmospheric pressure plasma jet (APPJ) in argon. The production of NO_2 was studied as a function of applied voltage, argon flow rate, and spatial distribution behind the jet.

The second part focuses on the detection of explosives including TNT, RDX, C-4, Semtex, PETN, and precursors such as DNT using IMS coupled with LD. Explosives were analysed from various types of surfaces commonly found in laboratory environments or post-blast scenes (drywall, stainless steel, aluminium, PVC, glass, wood, paper, and textile). Low detection limits (under 30 ng/mm²) were achieved for all tested analytes, confirming the applicability of IMS for forensic and security purposes.

In the third part, the thermal degradation of biodegradable polymers, polyhydroxybutyrate (PHB), polylactic acid (PLA), and the copolymer polybutylene adipate terephthalate (PBAT) was investigated. Using IMS and ToF-MS, degradation products formed by heating the polymers in the range of 25 – 100 °C were analysed. Based on the obtained mass spectra, these degradation products were identified. Biodegradable polymers represent a potential replacement for conventional plastics; however, understanding their thermal and chemical stability is essential for future applications.

Keywords: IMS, ToF-MS, LD, APPJ, rate constant, NO_2, explosives, biodegradable polymers