

Laser / Chemical Ionisation - Mass Spectrometry as an On-line Analysis Technique for Monitoring the Coffee Roasting Process

**R. DORFNER^{1,2}, T. FERGE^{1,2}, T. UCHIMURA^{1,3}, C. YERETZIAN⁴,
R. ZIMMERMANN^{1,5,6*}, A. KETTRUP^{1,2}**

¹GSF - Forschungszentrum für Umwelt und Gesundheit, Institut für Ökologische Chemie,
Ingolstädter Landstraße 1, 85764 Neuherberg, Germany

²Technische Universität München, Institut für Ökologische Chemie und Umweltanalytik,
85748 Freising, Germany

³Kyushu University, Department of Chemical Science and Technology, Hakozaki,
Fukuoka 812, Japan

⁴Nestlé Research Center, P.O. Box 44, CH-1000 Lausanne, Switzerland

⁵BifA - Bayerisches Institut für Angewandte Umweltforschung und - technik GmbH,
Am Mittleren Moos 46, 86167 Augsburg, Germany

⁶Universität Augsburg, Institut für Physik, Universitätsstraße 1, 86159 Augsburg, Germany

*Corresponding Author E-mail: ralf.zimmermann@gsf.de

SUMMARY

Coffee is one of the most popular beverages all over the world. In 1999, the members of the International Coffee Organisation exported 106 118 000 bags of green coffee beans (60 kg/bag). In the old days people roasted their coffee on their own, in pans above a fire. Nowadays large scaled industrial roasting machines are used for producing several kinds of coffees, coffee powders and beverages. The roasting process is controlled mainly by roast temperature and time. One of the most recent controlling techniques measures the temperature distribution within the beans. Until now, the release of flavour active compounds during roasting has not been taken into account, to monitor and eventually control the process. The monitoring of these volatile aromatic compounds and the introduction of a feedback steering based on these results may have the potential for improving the coffee roasting process, with respect to consistency (from batch to batch) and aroma quality.

One well suited analytical method for on-line, real-time monitoring of volatile compounds in industrial processes (Grosch, 1996) as well as food processes (Maier, 1984) is the REMPI-TOFMS technique. It allows a very fast, sensitive and selective detection of selected volatile components. This is necessary, in order to analyse complex gas mixtures without the need for sample preparation, cleaning and enrichment steps.

Here we present the application of this technique to the on-line analysis of coffee roasting. Green arabica beans of a defined provenience were roasted in a small scaled laboratory roasting machine, and the temporal evolution of the volatiles released from the beans were analysed by REMPI-TOFMS @ 266 and 193 nm. A single photon ionisation process (SPI) @ 118 nm was also used in order to obtain further information about relevant coffee compounds which are undetectable with one colour REMPI.

These three wavelengths enable us to detect several flavour active and relevant compounds of coffee like phenols, furans, pyrroles, ketenes, aldehydes, and other heterocyclic, aromatic and non aromatic compounds. Due to the different time behaviour of several compounds, the ratio of certain compounds will be suitable as indicator for important process conditions like roast

level and quality of the process control (Grosch , 1990). Our newly developed device is able to switch between a REMPI @ 266 nm and a SPI @ 118 nm mode from laser pulse to pulse. The two ionisation methods, a highly selective and a medium selective photon ionisation, are combined in a small (0.6 m x 0.8 m x 1.8 m – incl. DAQ), mobile device also containing a small (19' rack) TOFMS