

Highlights of Analytical Chemistry in Switzerland

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On-Line Process Control of the Roast Degree of Coffee

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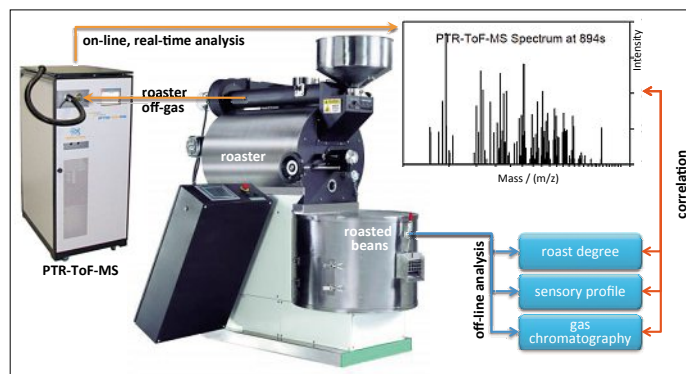
The flavour of roasted coffee.

Photo: http://mi9.com/wallpaper/i-love-coffee-wallpaper_80513/

The flavour of a freshly prepared cup of coffee is the final expression and perceptible result of a long chain of transformations. Along this journey from the seed to the cup, roasting is without doubt the most significant processing step. First, from a quality perspective, it is the very step where the coffee aroma is unlocked and formed from the precursors in the green bean. Second, from an economic perspective, it defines whether the potential in the green beans is expressed in the cup and materializes also in economic terms – even the best crop can be spoiled if not properly roasted.

Here we report on the development of a fast on-line process control technology for a consistent roast, batch after batch. It involves the on-line monitoring of the roaster off-gas using Proton-Transfer-Reaction Time-of-Flight Mass-Spectrometry (PTR-ToF-MS) and the analysis of the PTR-ToF-MS data *via* principle component analysis (PCA) to predict the roast degree in real time. The PCA was calibrated in advance with a large number of roasting trials, to develop the predictive model.

During each roasting cycle, the roaster off-gas is analysed on-line by PTR-ToF-MS, as a means to follow the evolution of the roasting process. Furthermore, the roast degree, the sensory profile (human panel) and the profile of volatile flavour compounds (gas chromatography) are measured off-line. To link the time-dependent PTR-ToF-MS mass profile with off-line measured quality attributes of coffee, a large number of ‘calibration experiments’ were performed. This allowed in a first study the development of a predictive model for the roast



Experimental strategy implemented for a real-time process control of the roast degree by on-line monitoring roaster off-gas *via* PTR-ToF-MS.

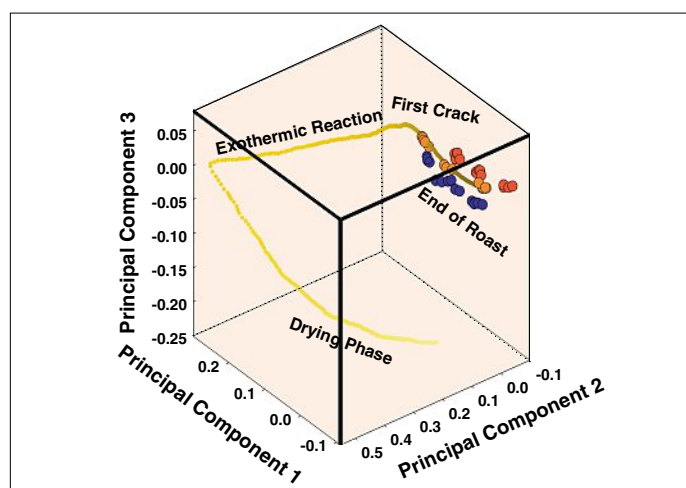
degree based on on-line monitored PTR-ToF-MS profiles. More specifically, the off-line determined roast degree was calibrated against the PTR-ToF-MS data (intensity of a series of relevant ion masses) at the end point of each roasting cycle, using multivariate statistical analysis, and a predictive model was derived. These ion masses were subsequently monitored on-line and the roast degree predicted during a roasting cycle.

This research demonstrates that a time-resolved analysis of the roaster off-gas by PTR-ToF-MS provides a detailed picture of the evolution of the roasting process and allows establishing a real-time process control tool to ensure highest consistency of the roast degree.

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Reference

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Principal component analysis to predict the roast degree of coffee. Experimental data of different roasting temperatures are shown (red: high, orange: medium, blue: low) in the 3D-space of the three most important principal components. The predicted roasting degree in real-time is shown as a yellow trace, here for a specific roasting process at medium temperature.

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