PAC

Process Analytical Chemistry - Data Acquisition and Data Processing

Main location	Linz (Upper Austria)
Other locations	Kundl (Tirol), Salzburg, Lenzing (Upper Austria), Krems (Lower Austria), Vienna
Thematic field	Gaining valid chemical information directly from the process streams of chemical and biochemical industry, inline and in real-time.

Success story summary

"nano-scale magnifier" for chemical analyses

Scientists of the research network PAC made significant progress towards non-destructive chemical imaging in the nanometer range. Through the combination of an atomic force microscope and infrared laser radiation from novel quantum cascade lasers chemical information can be obtained with an up to 1000-fold higher spatial resolution than achieved with conventional infrared imaging techniques. The "nano-scale magnifier" is already in use for the analysis of fungi employed for the production of antibiotics and will serve as a tool for the study of tumor tissues in the future.

Success story

Scientists at Vienna University of Technology recently made headway in their research activities in the field of chemical imaging. They succeeded to advance a powerful new imaging technique for chemical analysis of biological samples. The underlying analytical method was first demonstrated in 2006 by French scientists and is based on the combination of two established analytic techniques - the atomic force microscopy (AFM) and mid-infrared spectroscopy. The latter is known to provide high quality molecular specific information of the specimen under investigation and therefore offers insight in the fundamental chemical composition of various kinds of materials, particularly biological samples. What is new, however, is the use mid-infrared laser radiation provided by novel quantum cascade lasers (QCL) technology. The research group of Prof. Lendl at Vienna University of Technology has been playing a leading role in the application of this new laser source for chemical analysis in the last decade. Altough mid-infrared spectroscopy is already employed for chemical imaging it faces a principal physical limitation: the achievable spatial resolution is limited by the light wavelength. Since wavelengths that correspond to mid-infrared radiation are in the range of several micrometers, the spatial resolution is limited to this range, too. The combination of mid-infrared spectroscopy with atomic force microscopy circumvents this physical limitation, simply by probing the thermal expansion of the sample induced by the mid-infrared light instead of detecting the light in the far-field. If the laser light is adjusted to a wavelength where a specific type of molecule within the sample shows absorption this will lead to a thermal expansion of some nanometers. The expansion of the sample can in turn be detected by the AFM – with an up to 1000-fold higher spatial resolution, resulting in a highly resolved chemical image of the sample under investigation. Based on the research activities within PAC and the related results the technique can now be applied for destruction-free analysis of biological samples, which is a major step forward in biological chemical analysis. The Austrian scientists have been in close contact with international research groups during their research activities, among them the renowned National Institute of Standards and Technology (NIST) and the University of Texas, Austin, both USA.

Impact and effects

The "nano-scale magnifier" is already in use for the analysis of special fungi types that are employed for the production of antibiotics. In the future this method will also be applied as a tool for the investigation of tumor tissue.

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