Press-Release

8th of April 2017

“Corrective glass” for mass spectrometry imaging

The distribution of chemical substances on samples with non-flat surfaces can now be visualized

Jena. The chemical analysis of biological tissues with three-dimensional shapes has previously been a major problem. Researchers from three different institutes of the Beutenberg Campus in Jena, Germany, together have now improved mass spectrometry imaging in a way that the distribution of molecules can be visualized on warped, hairy, or coarse surfaces. Prof. Hans Peter Saluz of the Leibniz Institute for Natural Product Research and Infection Biology – Hans Knöll Institute (HKI) joined as scientific expert with long lasting experience in imaging and technology development at the interface between biology, physics and chemistry. In addition, he is the supervisor of Benjamin Bartels, the first author of this study. The source of the laser-based technique was custom-built in the group of Dr. Aleš Svatoš in the Max Planck Institute for Chemical Ecology (MPI-CE) to accommodate the topography of non-flat samples. By employing a distance sensor, a height profile of the surface is recorded before the actual chemical imaging. Dr. Norbert Danz from the Fraunhofer Institute for Applied Optics and Precision Engineering (IOF) designed a specific lens system for infrared lasers. The improved tool opens entirely new perspectives for answering, e.g. ecological questions (RSC Advances, January 2017, DOI: 10.1039/C6RA26854D)

Laser ablation electrospray ionization (LAESI) is a method that can be applied in mass spectrometry imaging to investigate the distribution of many different chemical compounds within a biological sample. The laser is used to remove a small fraction of the sample by local heating. The illuminated part of the sample bursts and the escaping vapor is ionized by an electrically charged mist to make the vapor contents detectable in a mass spectrometer. "The spatially confined laser probing enables us to assemble chemical information very much like pixels form an image,” Aleš Svatoš, the leader of the new study, explains the technical principles of the technique.

The distribution of chemical compounds, for example in flowers, leaves, stalks and other parts of a plant are of major importance in ecological research. Many of these chemical compounds, used to communicate between individual organisms, are so called secondary metabolites which are produced by plants and other organisms to attract pollinators or to fend off herbivores or pathogens, for example. It is important to know if or not a plant produces these substances, but the location, where within the plant tissue the molecules accumulate, can also be crucial. Is a defensive substance distributed evenly in a plant leaf or are there special glands that provide protection by secreting this chemical? In which parts of an insect exoskeleton are toxins or pheromones for communicating with their conspecifics, symbionts or competitors specifically enriched? Scientists in Jena seek to unravel how microbes and higher organisms interact with each other on a molecular level, with the aim to rebalance ecological systems. Thus, the three involved institutes MPI-CE, HKI and IOF provide a sound basis with their excellent cooperation.

“The biggest challenge in analytics is preserving the constitution of a sample throughout the analytical process. More often than not, sample preparation influences the result by altering the sample’s chemical constitution. Typical preparation steps include sectioning a sample into thin, flat slices because flatness is required to guarantee optimal laser focus, a key parameter in reliable analysis.“, Benjamin Bartels, PhD student in the Mass Spectrometry Research Group at the MPI-CE, points out the limitations of previous setups.

But most biological samples have surfaces which are far from being flat: For example, plant leaves often have hairy structures or they are warped. Caterpillars can also be hairy, and they are generally rather bulgy than flat. The Jena scientists have therefore adapted the LAESI technique to non-flat surfaces to open up the possibility of performing chemical imaging of samples with pronounced three-dimensional shapes while maintaining the reliability of classical measurements.

The improved laboratory setup measures the height profile of the surface in question prior to the actual mass spectrometry imaging. The recorded height profiles can be used to correct the distance between the focusing lens of the laser and the sample’s surface. In this way one of the essential parameters for reliable laser probing is kept constant throughout the experiment on samples with three-dimensional structure which were previously not subjectable to such analysis. “This means, that we can now investigate molecular distributions on a much bigger range of accessible surfaces. I am thinking of insect exoskeletons or microbial colonies within their natural environment. We can now also compare the contents of different trichomes of a leaf,” Benjamin Bartels emphasizes the advantages of the LAESI enhancements.

In the near future the researchers plan to implement further improvements and refinements. It is their goal to use LAESI also in routine measurements of non-flat surfaces. [BB/AO/HPS/SG]

Original Publication

Bartels B, Kulkarni P, Danz N, Böcker S, Saluz HP, Svatoš A (2017) Mapping metabolites from rough terrain: laser ablation electrospray ionization on non-flat samples. RSC Advances 7, 9045-9050, DOI: 10.1039/C6RA26854D
http://dx.doi.org/10.1039/C6RA26854D

Figure Legends

csm_LAESI_advanced_BB_b8c6b832fc.jpg (3,7 KiB)
Custom-built laser source for imaging mass spectrometry: With the improved Laser-Ablation-Electrospray-Ionisation (LAESI) setup surfaces of warped samples, like this piece of a savoy cabbage leave, can now be analysed.
Copyright: Benjamin Bartels, MPI Chem. Ecol.

csm_topography_savoy_cabbage_de_58d5a947b6.jpg (2,9 KiB)
Height profile of a piece of savoy cabbage (4 x 4 mm). The maximum difference in height is 2.38 mm.
Quelle: Benjamin Bartels, MPI Chem. Ecol.

Further Information

Dr. Aleš Svatoš, Max Planck Institute for Chemical Ecology, Hans-Knöll-Straße 8, 07745 Jena, Germany, E-Mail svatos [at] ice.mpg.de, Tel.: +49 3641 57 1700

Prof. Dr. Hans Peter Saluz, Leibniz-Institut für Naturstoff-Forschung und Infektionsbiologie – Hans-Knöll-Institut, Adolf-Reichwein-Straße 23, 07745 Jena, hanspeter.saluz@leibniz-hki.de, +49 3641 1201

Download high-resolution images via
http://www.ice.mpg.de/ext/downloads2017.html

Information on the HKI

Das Leibniz-Institut für Naturstoff-Forschung und Infektionsbiologie – Hans-Knöll-Institut – wurde 1992 gegründet und gehört seit 2003 zur Leibniz-Gemeinschaft. Die Wissenschaftler des HKI befassen sich mit der Infektionsbiologie human-pathogener Pilze. Sie untersuchen die molekularen Mechanismen der Krankheitsauslösung und die Wechselwirkung mit dem menschlichen Immunsystem. Neue Naturstoffe aus Mikroorganismen werden auf ihre biologische Aktivität untersucht und für mögliche Anwendungen als Wirkstoffe zielgerichtet modifiziert.

Das HKI verfügt über fünf wissenschaftliche Abteilungen, deren Leiter gleichzeitig berufene Professoren der Friedrich-Schiller-Universität Jena (FSU) sind. Hinzu kommen mehrere Nachwuchsgruppen und Querschnittseinrichtungen mit einer integrativen Funktion für das Institut, darunter das anwendungsorientierte Biotechnikum als Schnittstelle zur Industrie. Gemeinsam mit der FSU betreibt das HKI die Jena Microbial Resource Collection, eine umfassende Sammlung von Mikroorganismen und Naturstoffen. Zurzeit arbeiten etwa 400 Personen am HKI, davon 130 als Doktoranden.

Das HKI ist Initiator und Kernpartner großer Verbundvorhaben wie der Exzellenz-Graduiertenschule Jena School for Microbial Communication, der Sonderforschungsbereiche FungiNet (Transregio) und ChemBioSys, des Zentrums für Innovationskompetenz Septomics sowie von InfectControl 2020, einem Konsortium im BMBF-Programm Zwanzig20 – Partnerschaft für Innovation. Seit 2014 ist das HKI Nationales Referenzzentrum für invasive Pilzinfektionen.

Information on the Leibniz-Association

Die Leibniz-Gemeinschaft verbindet 91 selbständige Forschungseinrichtungen. Ihre Ausrichtung reicht von den Natur-, Ingenieur- und Umweltwissenschaften über die Wirtschafts-, Raum- und Sozialwissenschaften bis zu den Geisteswissenschaften. Leibniz-Institute widmen sich gesellschaftlich, ökonomisch und ökologisch relevanten Fragen. Sie betreiben erkenntnis- und anwendungsorientierte Forschung, auch in den übergreifenden Leibniz-Forschungsverbünden, sind oder unterhalten wissenschaftliche Infrastrukturen und bieten forschungsbasierte Dienstleistungen an. Die Leibniz-Gemeinschaft setzt Schwerpunkte im Wissenstransfer, vor allem mit den Leibniz-Forschungsmuseen. Sie berät und informiert Politik, Wissenschaft, Wirtschaft und Öffentlichkeit. Leibniz-Einrichtungen pflegen enge Kooperationen mit den Hochschulen ‐ u.a. in Form der Leibniz-WissenschaftsCampi, mit der Industrie und anderen Partnern im In- und Ausland. Sie unterliegen einem transparenten und unabhängigen Begutachtungsverfahren. Aufgrund ihrer gesamtstaatlichen Bedeutung fördern Bund und Länder die Institute der Leibniz-Gemeinschaft gemeinsam. Die Leibniz-Institute beschäftigen rund 18.600 Personen, darunter 9.500 Wissenschaftlerinnen und Wissenschaftler. Der Gesamtetat der Institute liegt bei mehr als 1,7 Milliarden Euro.

Contact Person

Dr. Michael Ramm
Scientific Organisation
Leibniz Institute for Natural Product Research and Infection Biology e. V.
– Hans Knöll Institute –
Adolf-Reichwein-Straße 23
07745 Jena

+49 3641 5321011
+49 176 54909562
presse@leibniz-hki.de
www.leibniz-hki.de