Curriculum Vitae

Univ.-Prof. Dr. techn. Bernhard Lendl

Position in CoE: Member of the Board of Directors

Personal Details

Place of birth	Salzburg, Austria
Nationality	Austrian
Children	2 (1997, 1999)
Affiliation:	Technische Universität Wien (TU Wien)
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Profile	ReseacherID: A-4069-2013
List of publications	ORCID: 0000-0003-3838-5842
Academic age	26 years since PhD

Research Institution

I am a member of the **Institute of Chemical Technologies and Analytics (CTA) of the Faculty of Technical Chemistry of the Technische Universität (TU) Wien**. Our institute comprises five research divisions with a total of thirteen research groups. I am the **head** of the research division of **Environmental Analytics, Process Analytics and Sensors** and of the research group of **Process Analytics**.

Academic Career and Positions Held

I earned a Master's degree in **Technical Chemistry from the TU Wien**, Austria, in 1993 and received my **doctoral degree** from the same institution in **1996** (*summa cum laude*). Subsequently, I worked as a **PostDoc** with Richard A. Palmer at **Duke University** (NC. USA); this work was financed through my first FWF project grant, which I obtained as a doctoral student. When my supervisor Robert Kellner passed away in 1997, I took over the **research group of chemical analysis and infrared spectroscopy at TU Wien**, where I obtained my **habilitation** (*venia docendi*) in **Analytical Chemistry** in **2001**. In the academic year of 2003–2004, I was a **guest professor at Córdoba University** in Spain, financed by the Spanish Ministry of Education, Culture and Sport. In 2008, I founded **QuantaRed Technologies (QRT)**, where I am still serving as **scientific director**. QRT develops and commercializes analysers based on mid-IR quantum cascade lasers for customers from the **oil & gas industry**. I was promoted to f**ull professor for Vibrational Spectroscopy at TU Wien** in 2016. I contributed significantly to the f**oundation of the competence centre of CHASE** (Chemical Systems Engineering) in 2018, where I am active as a key researcher.

So far, I was PI in **8 stand-alone FWF projects** (basic research) and **PI in 15 FFG/ZIT projects** (applied research). On an international level, I coordinated the Marie Curie Training Site ADVIS (2002–2004) and have participated as PI in 14 and as co-PI in 2 further **European projects** during FP6, FP7 and H2020 (RIA, IA, EJD-ITN), with 8 projects currently running and 2 more granted. Overall, I have received funding for >**16.5 Mio.€**. My current publication record (Web of Science, October 2022) shows **358 publications, > 8,100 citations** and indicates an h-index of 43. I have presented **84 invited talks** at conferences and research institutions, written 14 book chapters and filed **15 patent applications** which have led to granted patents in AT, DE, GB, FR, US, CA, JP, RU and CN. Relevant awards include the **Robert Kellner Lecture DAC (EuCheMS, 2015), the Anton Paar Research Award (2018) and the Agilent Thought Leader Award (2021)**. In 1998, I chaired the 3rd International Symposium on Advanced Infrared Spectroscopy (AIRS III) with 300 participants in Vienna. I worked with others to merge the AIRS series with the larger ICOFTS (international conference on Fourier transform spectroscopy) conference series to the International Conference on Advanced Vibrational

Spectroscopy (ICAVS) series (2001). In 2015, I chaired ICAVS-8 at TU Wien (650 participants) and in 2021, I stepped down from the international ICAVS steering committee.

Main Research Areas and Most Important Research Achievement

Main Research Areas. We advance analytical sciences through the development of **novel analytical techniques** and instrumentation **based on infrared and Raman spectroscopy**. Regarding IR spectroscopy, we mainly use novel mid-IR sources such as quantum cascade lasers (QCLs) and recently also frequency combs. We exploit the unique features of QCLs in terms of size, room-temperature operation, achievable spectral power densities, broad tuning range, inherent coherence and polarization as well as rapid amplitude and frequency modulation capabilities to develop new sensing schemes for **gases, liquids and for nanoscale mid-IR imaging** applications. Direct access to label-free information as provided by vibrational spectra also allows for unique **application** possibilities in **environmental and process analytical chemistry, material characterization** as well as in the **life sciences** at large. A key aspect of our research is the application of our analyzer prototypes to real-world problems. This includes installation and testing at industrial co-operation partners, field test with the **Austrian Armed Forces**, as well as in-house applications at TU Wien for upstream and downstream **bioprocess monitoring**.

Most important research achievements. We invented a mid-IR laser-based gas sensor technology that allows us to implement highly sensitive, albeit **miniaturized gas sensors** capable to **differentiate** between **isotopologues**. Modulated light absorption by the gaseous analyte induces periodic temperature and hence refractive index changes of the sample matrix. Using our **patented ICAPS** (interferometric assisted photothermal spectroscopy) technology, we can detect such changes in **small sample volumes** (less than 0.5 mL) with high sensitivity in the single-digit ppb concentration range.

We also pioneered key developments in bio-molecular and biological nanoscale infrared **chemical imaging**. Using **AFM-IR** – a technique that performs nanoscale mid-IR imaging and spectroscopy at roughly 20 nm spatial resolution by reading out local heating by an IR laser via a scanning probe tip – we were able to follow **polypeptide folding processes** in a **time-resolved** manner at n**anometer spatial resolution**. We have demonstrated nanoscale-spatial-resolution secondary structure analysis of amide fibrils in aqueous environments. As we have shown, AFM-IR is also able to determine the loading of sub-100 nm diameter lipid vesicles. When combined with **machine learning**, AFM-IR can be used for computational staining of a filamentous fungus at nanometer resolution.

Scientific contribution to the CoE. Within this CoE, we will mainly contribute by **providing innovative analytical-chemical techniques for microbiome research**. In particular, we will develop and provide **isotope-specific, mid-IR laser-based trace gas sensors** as well as new **label-free nanoscale mid-IR imaging** technology for microorganism interaction studies and for the analysis of individual extracellular vesicles. Two further research groups of our faculty will participate in this CoE: the Cell Chip (Peter Ertl) and Bioanalytics (Ruth Birner-Grünberger) groups will provide dedicated lab-on-a-chip technology for the individual projects as well as know-how and laboratory infrastructure for performing metaproteomic and metabolomic studies.

10 Most Important Publications (*relevant for the CoE)

1. Hinkov, B.; Pilat, F.; Lux, L.; Souza, P. L.; David, M.; Schwaighofer, A.; Ristanić, D.; Schwarz, B.; Detz, H.; Andrews, A. M.; **Lendl, B.**; Strasser, G. A Mid-Infrared Lab-on-a-Chip for Dynamic Reaction Monitoring. *Nat Commun* **2022**, *13* (1), 4753. *https://doi.org/10.1038/s41467-022-32417-7*.
2. *Freitag, S.; Baumgartner, B.; Radel, S.; Schwaighofer, A.; Varriale, A.; Pennacchio, A.; D'Auria, S.; **Lendl, B.** A Thermoelectrically Stabilized Aluminium Acoustic Trap Combined with Attenuated Total Reflection Infrared Spectroscopy for Detection of Escherichia Coli in Water. *Lab Chip* **2021**, *21* (9), 1811–1819. *https://doi.org/10.1039/D0LC01264E*.
3. *Waclawek, J. P.; Moser, H.; **Lendl, B.** Balanced-Detection Interferometric Cavity-Assisted Photothermal Spectroscopy Employing an All-Fiber-Coupled Probe Laser Configuration. *Opt. Express* **2021**, *29* (5), 7794. *https://doi.org/10.1364/OE.416536*.
4. *V. D. dos Santos, A. C.; Heydenreich, R.; Derntl, C.; Mach-Aigner, A. R.; Mach, R. L.; Ramer, G.; **Lendl, B.** Nanoscale Infrared Spectroscopy and Chemometrics Enable Detection of Intracellular Protein Distribution. *Anal. Chem.* **2020**, *92* (24), 15719–15725. *https://doi.org/10.1021/acs.analchem.0c02228*.
5. *Ramer, G.; Balbekova, A.; Schwaighofer, A.; **Lendl, B.** Method for Time-Resolved Monitoring of a Solid State Biological Film Using Photothermal Infrared Nanoscopy on the Example of Poly- L -Lysine. *Anal. Chem.* **2015**, *87* (8), 4415–4420. *https://doi.org/10.1021/acs.analchem.5b00241*.
6. Wieland, K.; Ramer, G.; Weiss, V. U.; Allmaier, G.; **Lendl, B.**; Centrone, A. Nanoscale *Chemical Imaging of Individual Chemotherapeutic Cytarabine-Loaded Liposomal Nanocarriers. *Nano Res.* **2019**, *12* (1), 197–203. *https://doi.org/10.1007/s12274-018-2202-x*.
7. Baumgartner, B.; Hayden, J.; Schwaighofer, A.; **Lendl, B.** In Situ IR Spectroscopy of Mesoporous Silica Films for Monitoring Adsorption Processes and Trace Analysis. ACS Appl. *Nano Mater.* **2018**, *1* (12), 7083–7091. *https://doi.org/10.1021/acsanm.8b01876*.
8. *Ofner, J.; Deckert-Gaudig, T.; Kamilli, K. A.; Held, A.; Lohninger, H.; Deckert, V.; **Lendl, B.** Tip-Enhanced Raman Spectroscopy of Atmospherically Relevant Aerosol Nanoparticles. *Anal. Chem.* **2016**, *88* (19), 9766–9772. *https://doi.org/10.1021/acs.analchem.6b02760*.
9. *Koch, C.; Brandstetter, M.; Wechselberger, P.; Lorantfy, B.; Plata, M. R.; Radel, S.; Herwig, C.; **Lendl, B.** Ultrasound-Enhanced Attenuated Total Reflection Mid-Infrared Spectroscopy In-Line Probe: Acquisition of Cell Spectra in a Bioreactor. *Anal. Chem.* **2015**, *87* (4), 2314–2320. *https://doi.org/10.1021/ac504126v*.
10. *Waclawek, J. P.; **Lendl, B.** Photothermal Interferometry Apparatus and Method. Priorities: AT506242016A·**2016-07-13**; Application: AT2017060174W·**2017-07-12**, Published as: CA3025935A1; CA3025935C; CN109416318A; EP3485254A1; EP3485254B1; JP2019520570A; JP6786752B2; RU2716146C1; US10732097B2; US2019195781A1; WO2018009953A1