Prof. Dr. habil. Bernhard Roth

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Academic career

2014	Professor in Physics Faculty of Mathematics and Physics Gottfried Wilhelm Leibniz University of Hannover
2012	Habilitation and Venia legendi in Physics Faculty of Mathematics and Physics Gottfried Wilhelm Leibniz University of Hannover
2007	Habilitation and Venia legendi (Dr. habil.) in Experimental Physics Quantum Optics, Ultracold Molecules, High-Precision Spectroscopy Heinrich-Heine University Duesseldorf Topic: „Production, Manipulation and Spectroscopy of Cold Trapped Molecular Ions“
2001	Ph.D. in Physics (Dr. rer. nat.), University of Bielefeld Atomic and Particle Physics Topic: „Spin-dependent asymmetry functions in the elastic and inelastic electron-cesium-scattering at intermediate energies“
1997	Diploma in Physics, University of Bielefeld Atomic and Particle Physics Topic: Investigation of spin-dependent effects and differential cross sections in the elastic electron-cesium scattering
1992	Study of Physics (Diploma), University of Bielefeld

Professional career

Since 2019	Principal Investigator in Cluster of Excellence PhoenixD – Photonics, Optics, and Engineering - Innovation Across Disciplines (German Research Foundation, DFG), Leibniz University Hannover, Germany
Since 2012	Scientific and Managing Director, Hannover Centre for Optical Technologies HOT, Gottfried Wilhelm Leibniz University of Hannover

2011-2012	Center Manager and Scientific Director, innoFSPEC Potsdam (Center for Innovation Competence), Leibniz Institute for Astrophysics Potsdam and University of Potsdam
2007-2010	Associate Professor (Privatdozent) at the Heinrich-Heine University Duesseldorf Research fields: Production, manipulation and high-precision laser spectroscopy of cold trapped molecular ions
2002-2007	Head of the Precision Laser Spectroscopy Group (Habilitand), Institute for Experimental Physics, Heinrich-Heine University Duesseldorf
2001	Research associate (Postdoctoral fellow), University of Bielefeld
1997-2001	Research associate (Ph.D.), University of Bielefeld

Memberships

Since 1991	German Physical Society DPG
Since 2015	European Physical Society EPS
Since 2020	The International Society for Optics and Photonics SPIE

Awards

2024	Helmholtz Prize in the field of Applied Metrology for innovations in optical biopsy for skin cancer diagnostics, Helmholtz-Fonds and PTB, Germany
2021	Kaiser-Friedrich Research Award (2020) for Photonic Technologies in Environmental and Climate Protection, Fraunhofer Society, Goslar, Germany
2018	Kaiser-Friedrich Research Award for Photonic Technologies for the Digital Laboratory, Fraunhofer Society, Goslar, Germany
2017	University and Research Award, hannoverimpuls, City of Hannover, Germany
2017	Going Global – Internationalisation Award, hannoverimpuls, City of Hannover, Germany
2017	Digital Business & Technology Award, hannoverimpuls, City of Hannover, Germany
2007	Young Researcher/Academics award, German-Israeli Foundation for Scientific Research and Development GIF
2006	Young Researcher/Academics award, Heinrich-Heine University Duesseldorf, Germany

Research interests

My research interests and main motivation lie in the area of *optics and photonics* as well as their applications in medicine, life sciences, sensing or monitoring.
Coming from the field of *atomic and particle physics* as well as *quantum optics and precision metrology* I strive to translate fundamental research in optics and photonics into applications and to develop novel functionalities or measurement systems relying on the unique and, in particular, the quantum properties of the light. These enable to use light as both a highly precise tool for light-matter interaction and manipulation as well as for accurate characterization and testing.

In order to achieve these goals, I am also involved in developing new, hybrid tools for numerical modeling and simulation of light-matter interactions as firm basis for the complex processes studied in the life sciences on one side and the realization of polymer-based sensor arrays and networks enabling cost-efficient, and yet precise and reliable light-based measurement and imaging devices for every-day use on the other side. Within the Cluster of Excellence PhoenixD – Photonics, Optics, and Engineering - Innovation Across Disciplines (German Research Foundation, DFG) of Leibniz University Hannover I investigate and validate new technologies for integrated optics and photonics production and application, e.g. for environmental analytics, point-of-care testing or production monitoring. Within this endeavor, techniques for additive and subtractive manufacturing and UV nanoimprint replication of micro- and nanooptics are combined in a closed feedback-loop production chain to enable error-free manufacturing of future precision optics and measurement systems.

Organization of International Conferences / Guest Editor Activities (selected)

Organization of International Conference on Applied Optics and Photonics 2016 together with the 117th Annual Meeting of the German Society of Applied Optics DGAO, Joint Conference of the German Society of Applied Optics DGAO, the International Commission for Optics ICO (Topical Meeting) in cooperation with the Hannover Centre for Optical Technologies HOT of the Leibniz University Hannover, Hannover, Germany

Guest Editor for Special Issue “State-of-the-Art Sensors Technology in Germany” in Journal Sensors (MDPI, ISSN 1424-8220), Section “State-of-the-Art Sensors Technologies” (2018)

Session Chair at national and international conferences (examples):

- International Conference on Applied Optics and Photonics 2016 together with the 117th Annual Meeting of the German Society of Applied Optics DGAO, Hannover, Germany
- Photonics West 2018, OPTO, MOEMS and Miniaturized Systems, San Francisco, USA
- International Symposium on Future Optics 2019, Hannover, Germany
- OPORTO 22 - 1st Spring Biophotonics Conference 2022, Porto, Portugal
- 25th Congress of the International Commission for Optics (ICO-25) and 16th Conference of the International Society on Optics within Life Sciences (OWLS-16) 2022, Dresden, Germany

Institutional and general responsibilities (selected)

Since 2023	Fellow of the Max Planck School of Photonics, Max Planck Society, Munich, Germany
Since 2020	Board Member of the Leibniz School of Optics and Photonics (LSO), in Cluster of Excellence PhoenixD – Photonics, Optics, and Engineering - Innovation Across Disciplines (German Research Foundation, DFG), Leibniz University Hannover, Germany
Since 2019	Member of Steering Committee and Task Area Leader (Metrology) in Cluster of Excellence PhoenixD – Photonics, Optics, and Engineering - Innovation Across Disciplines (German Research Foundation, DFG), Leibniz University Hannover, Germany
Since 2016	Coordinator PhD program Tailored Light with in total 17 PhD students
Since 2012	Coordinator Master Course Optical Technologies (German/English)
Since 2012	Publisher of the regular HOT Workshop Conference Proceedings on topic in Optics and Photonics

Selected Publications

A. Günther, Y. Deja, M. Kilic, K. Tran, P. Kotra, F. Renz, W. Kowalsky, and **B. Roth** (2024): Investigation of the molecular switching process between spin crossover states of triazole

complexes as basis for optical sensing applications. Nature Scientific Reports 14:5897, doi.org/10.1038/s41598-024-56427-1

A. Fedorov Kukk, F. Scheling, R. Panzer, S. Emmert, and **B. Roth** (2023): Combined ultrasound and photoacoustic C-mode imaging system for skin cancer assessment. Nature Scientific Reports 13:17947, doi.org/10.1038/s41598-023-44919-5

L. Zheng, T. Birr, U. Zywietz, C. Reinhardt, and **B. Roth** (2023): Feature size below 100 nm realized by UV-LED-based microscope projection lithography. Light: Advanced Manufacturing 4:33, doi.org/10.37188/lam.2023.033

C. Wetzel, L. Jansen-Olliges, M. Stadler, F. Surup, C. Zeilinger, and **B. Roth** (2023): Analysis of SARS-CoV-2 spike RBD binding to ACE2 and its inhibition by fungal cohaerin C using surface enhanced Raman spectroscopy. Biomedical Optics Express 14(8), 4097-4111, doi.org/10.1364/BOE.495685

T. Grabe, T. Biermann, A. Wolf, J. Al-Nuwaider, H. Krauss, J. August, W. Yu, J.B. Heinz, M. Bayerl, K. Xu, Q. Wang, J. Wu, **B. Roth**, W. Ren, and R. Lachmayer (2023): Application-inspired additive manufacturing of Raman optics. Optics and Laser Technology 165, 109574, doi.org/10.1016/j.optlastec.2023.109574

A. Fedorov Kukk, D. Wu, E. Gaffal, R. Panzer, S. Emmert, and **B. Roth** (2022): Multimodal system for optical biopsy of skin cancer with integrated ultrasound, optical coherence tomography and localized Raman spectroscopy. Journal of Biophotonics 15(10), e202200129, doi.org/10.1002/jbio.202200129

L. Zheng, N. Keppler, H. Zhang, P. Behrens, and **B. Roth** (2022): Planar Polymer Optical Waveguide with Metal-Organic Framework Coating for Carbon Dioxide Sensing. Advanced Materials Technologies, 2200395, doi: 10.1002/admt.202200395

L. Zheng, U. Zywietz, T. Birr, M. Duderstadt, L. Overmeyer, **B. Roth**, and C. Reinhardt (2021): UV-LED projection photolithography for high-resolution functional photonic components. Microsystems and Nanoengineering: 7:64, doi.org/10.1038/s41378-021-00286-7

O. Melchert, S. Willms, S. Bose, A. Yulin, **B. Roth**, F. Mitschke, U. Morgner, I. Babushkin, and A. Demircan (2019): Soliton molecules with two frequencies. Phys. Rev. Lett. 123, 243905, doi.org/10.1103/PhysRevLett.123.243905

J. Kanngiesser, M. Rahlves, and **B. Roth** (2019): Double Interferometer Design for Independent Wavefront Manipulation in Spectral Domain Optical Coherence Tomography. Nature Scientific Reports 9:14651, doi.org/10.1038/s41598-019-50996-2

O. Melchert, M. Wollweber, and **B. Roth** (2019): Optoacoustic inversion via convolution kernel reconstruction in the paraxial approximation and beyond. Photoacoustics 13, 1-5, doi.org/10.1016/j.pacs.2018.10.004

A. Varkentin, M. Mazurenka, E. Blumenröther, L. Behrendt, S. Emmert, U. Morgner, M. Meinhardt-Wollweber, M. Rahlves, and **B. Roth** (2018): Trimodal system for in vivo skin cancer screening with combined OCT-Raman and co-localized optoacoustic measurements. Journal of Biophotonics 11(6), 11:e201700288, doi: 10.1002/jbio.201700288

M. Meinhardt-Wollweber, A. Heratizadeh, C. Basu, A. Günther, S. Schlangen, T. Werfel, V. Schacht, S. Emmert, H. A. Haenssle, and **B. Roth** (2017): A non-contact remote digital dermoscope to support cancer screening and diagnosis of inflammatory skin disease. Biomed. Phys. Eng. Express 3, doi: 10.1088/2057-1976/aa84d3

A. Varkentin, M. Mazurenka, E. Blumenröther, M. Meinhardt-Wollweber, M. Rahlves, S.M.C. Broekaert, S. Schäd-Trcka, S. Emmert, U. Morgner, and **B. Roth (**2016): Comparative study of presurgical skin infiltration depth measurements of melanocytic lesions with OCT and high frequency ultrasound, J. of Biophotonics 10, 854–861, doi: 10.1002/jbio.201600139

A.-K. Kniggendorf, R. Nogueira, C. Kelb, P. Schadzek, M. Meinhardt-Wollweber, A. Ngezahayo, and **B. Roth** (2016): Confocal Raman Microscopy and Fluorescent in situ Hybridization - a complementary approach for biofilm analysis, Chemosphere, 2016

E. Blumenröther, O. Melchert, M. Wollweber, and **B. Roth** (2016): Detection, numerical simulation and approximate inversion of optoacoustic signals generated in multi-layered PVA hydrogel based tissue phantoms, Photoacoustics 4 (2016) 125-132

C. Kelb, R. Rother, A.-K. Schuler, M. Hinkelmann, M. Rahlves, O. Prucker, C. Mueller, J. Rühe, E. Reithmeier, and **B. Roth** (2016): *Manufacturing of embedded multimode waveguides by reactive lamination of cyclic olefin polymer and polymethylmethacrylate*, Opt. Eng. 55(3), 037103 (2016)

A.B. Petermann, A. Varkentin, **B. Roth**, U. Morgner, and M. Meinhardt-Wollweber (2016): *All-polymer whispering gallery mode sensor in the low-Q regime*, Optics Express 24(6), 6052-6062 (2016)

K. Bremer, S. Lochmann, and **B. Roth** (2015): Grating assisted optical waveguide coupler to excite individual modes of a multi-mode waveguide, Optics Communications 356 (2015) 560–564

D. Singh, C. Basu, M. Meinhardt-Wollweber, and **B. Roth** (2015): *LEDs for Energy Efficient Greenhouse Lighting*, Renewable and Sustainable Energy Reviews (Elsevier) 49, 139-147 (2015), doi:10.1016/j.rser.2015.04.117

C. Kelb, M. Rahlves, E. Reithmeier, **B. Roth** (2015): *Realization and performance of an all-polymer optical planar deformation sensor*, Sensors Journal, IEEE

K. Bremer, M. Meinhardt-Wollweber, T. Thiel, G. Werner, T. Sun, K.T.V. Grattan, and **B. Roth** (2014): *Sewerage tunnel leakage using a fibre optic moisture-detecting sensor system*, Sensors and Actuators A, 220, 62–68

A.-K. Kniggendorf, M. Meinhardt-Wollweber, X. Yuan, **B. Roth**, A. Seifert, N. Fertig, and C. Zeilinger (2014); Temperature-sensitive gating of hCx26: high-resolution Raman spectroscopy sheds light on conformational changes; Biomedical Optics Express, 5(7) 2054, DOI:10.1364/BOE.5.002054

D. Hoheisel, C. Kelb, M. Wall, **B. Roth**, L. Rissing (2013); *Fabrication of Adhesive Lenses Using Free Surface Shaping*, J. Europ. Opt. Soc. Rap. Public. 8, 13065

T. Schneider, **B. Roth**, H. Duncker, I. Ernsting, S. Schiller (2010); *All-optical Preparation of Molecular Ions in the Rovibrational Ground State;* Nature Physics 6, 275-278,

doi:10.1038/nphys1605

D. Offenberg, Ch. Wellers, C.B. Zhang, **B. Roth**, S. Schiller (2009); *Measurement of small photodestruction rates of cold, charged biomolecules in an ion trap;* J. Phys. B: At. Mol. Opt. Phys. 42, 035101

B. Roth, D. Offenberg, C.B. Zhang, S. Schiller (2008); *Chemical reactions between cold Ba^+ ions and neutral molecules in the gas phase*; Phys. Rev. A 78, 042709 (2008)

J. Koelemeij, **B. Roth**, I. Ernsting, A. Wicht, S. Schiller (2007); *Vibrational spectroscopy of HD+ with 2-ppb accuracy*; Phys. Rev. Lett. 98, 173002

A. Ostendorf, C. Zhang, A. Wilson, D. Offenberg, **B. Roth**, S. Schiller (2006); *Sympathetic cooling of complex molecular ions to millikelvin temperatures*; Phys. Rev. Lett. 97, 243005

B. Roth, J. Koelemeij, H. Daerr, S. Schiller (2006); Rovibrational spectroscopy of trapped molecular hydrogen ions at millikelvin temperatures; Phys. Rev. A 74, 040501(R) (2006).

B. Roth, U. Fröhlich, S. Schiller (2005); *Sympathetic cooling of $^4He^+$ ions in a Paul trap;* Phys. Rev. Lett. 94, 053001

Book contributions (selected)

B. Roth and S. Schiller, Sympathetically cooled molecular ions: from principles to first applications, Chapter for monography “Cold Molecules: Theory, Experiment, Applications”, B. Friedrich, R. Krems, W. Stwalley, Eds., CRC Press, Taylor and Francis (2009); ISBN 978-1420059038, CAT# 59033; see also arXiv:0812.1154v1[quant-ph]