

Abstract: Photonic Terahertz Spectrum Analyzers

Emerging photonic technologies are becoming competitive to established purely electronic solutions like vector network analysis or spectrum analysis. The talk will discuss photoconductors that are driven by a 1550 nm laser signal composed of two slightly detuned frequencies. The difference frequency of these can easily be chosen in the THz range. The photoconductor will mix the lasers, generating the difference frequency as a local oscillator (LO). Subsequently, this LO is mixed with an unknown THz signal under test, resulting in a down-converted intermediate frequency that is read out by post detection electronics. This approach enables a widely tunable spectrum analyzer with a bandwidth > 1 THz in a single system. Several setups and applications will be demonstrated, including a Hz-level resolution system.

Curriculum Vitae

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Personal Information

Name: Sascha Preu
Date of birth: June 25th, 1980 in Weißenburg/Bavaria, Germany
Nationality: German

Education

2005-2009 Dr. rer. nat. (summa cum laude)
Max-Planck Institute for the Science of Light/FAU Erlangen-Nuremberg,
Germany
Supervisor: Prof. Lijun Wang
Thesis title: Continuous-wave, tunable THz n-i-pn-i-p superlattice photomixers
and applications

2000-2005 Study of Physics; Diploma with distinction
FAU Erlangen-Nuremberg, Germany/University of York, UK
Diploma thesis supervisor: Prof. Lijun Wang
Thesis title: Continuous-wave Terahertz generation via photomixing in a
III-V nipnip structure

1999 Abitur, average mark 1.1
Werner-von-Siemens Gymnasium Weißenburg, Weißenburg i.Bay., Germany

Academic Career

Since 2018 Full Professor, head of Terahertz Devices and Systems Laboratory, Dept. of
Electrical Engineering and Information Technology, TU Darmstadt, Germany

2014-2018 Junior Professor, head of THz Systems Technology Group
Dept. of Electrical Engineering and Information Technology, TU Darmstadt,
Germany

2011 – 2014 Post-doctoral associate
Chair for Applied Physics, FAU Erlangen-Nuremberg, Germany

2010 – 2011 Feodor Lynen stipendiate/ Post-doctoral associate
Materials Dept./Physics Dept./Institute for THz Science and Technology,
University of California, Santa Barbara, USA

2009 – 2010 Post-doctoral associate
Max-Planck Institute for the Science of Light, Erlangen, Germany

Awards and fellowships

- IOP trusted reviewer, Institute of Physics Publishing (2019)
- ERC Starting Grant, European Research Council (2017)
- Humboldt fellow, Alexander von Humboldt Stiftung, Bonn, Germany (since 2010)
- Alumni of the “International Max-Planck Research School” (IMPRS optics and imaging, Erlangen, Germany, admitted 2006)
- Alumni of the “Studienstiftung des deutschen Volkes,” Germany (admitted 2003)
- Otto Hahn Medal for young researchers of the Max-Planck foundation for research on tunable Terahertz photomixers (2009/2010)
- Ohm prize of the Friedrich-Alexander Universität Erlangen-Nürnberg for the best dissertation in Physics in the academic year 2009/2010
- Ohm prize of the Friedrich-Alexander Universität Erlangen-Nürnberg for the best diploma thesis in Physics in the academic year 2005/2006

Ten most important publications

- S. Regensburger, S. Winnerl, J. M. Klopff, H. Lu, A. C. Gossard and S. Preu, "Picosecond-Scale Terahertz Pulse Characterization With Field-Effect Transistors," in IEEE Transactions on Terahertz Science and Technology **9**, pp. 262-271, (2019).
<https://doi.org/10.1109/TTHZ.2019.2903630>
- A. d. J. Fernandez Olvera, A. Roggenbruck, K. Dutzi, N. Vieweg, H. Lu, A.C. Gossard, and S. Preu, "International System of Units (SI) Traceable Noise-Equivalent Power and Responsivity Characterization of Continuous Wave ErAs:InGaAs Photoconductive Terahertz Detectors," Photonics **6**, 15, (2019).
<https://doi.org/10.3390/photonics6010015>
- M.T. Schlecht, S. Preu, S. Malzer, and H.B. Weber, „An efficient Terahertz rectifier on the graphene/SiC materials platform,” Scientific Reports **9**, 11205, (2019).
<https://doi.org/10.1038/s41598-019-47606-6>
- U. Nandi, J. C. Norman, A. C. Gossard, H. Lu, and S. Preu, "1550-nm Driven ErAs:In(Al)GaAs Photoconductor-Based Terahertz Time Domain System with 6.5 THz Bandwidth." Journal of Infrared, Millimeter, and Terahertz Waves **39**, pp. 340-348, (2018).
<https://doi.org/10.1007/s10762-018-0471-9>
- A.d.J. Fernandez Olvera, H. Lu, A.C. Gossard, and S. Preu, “Continuous-wave 1550 nm operated terahertz system using ErAs:In(Al)GaAs photoconductors with 52 dB dynamic range at 1 THz”. Optics Express **25**, 29492-29500 (2017).
<https://doi.org/10.1364/OE.25.029492>
- A. J. Deninger, A. Roggenbuck, S. Schindler, and S. Preu, „2.75 THz tuning with a triple-DFB laser system at 1550 nm and InGaAs photomixers,” J. Infrared Milli Terahz Waves **36**, 269-277 (2015).
<https://doi.org/10.1007/s10762-014-0125-5>
- H. Lu, D.G. Ouellette, S. Preu, J. D. Watts, B. Zaks, P.G. Burke, M.S. Sherwin, and A.C. Gossard, “Self-assembled ErSb nanostructures with optical applications in infrared and Terahertz”, Nano Lett. **14**, 1107-1112 (2014).
<https://doi.org/10.1021/nl402436g>
- S. Preu, M. Mittendorff, H. Lu, H. B. Weber, S. Winnerl and A. C. Gossard, “1550 nm ErAs:In(Al)GaAs large area photoconductive emitters,” Appl. Phys. Lett. **101**, 101105 (2012)
<https://doi.org/10.1063/1.4750244>

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- S. Preu, S. Kim, R. Verma, P. G. Burke, M. S. Sherwin, and A. C. Gossard, “*An improved model for non-resonant terahertz detection in field-effect transistors*,” J. Appl. Phys. **111**, 024502 (2012).
<https://doi.org/10.1063/1.3676211>
 - S. Preu, G. H. Döhler, S. Malzer, A. C. Gossard, and L. J. Wang, “*Tunable, Continuous-Wave Terahertz Photomixer Sources and Applications*,” **Review article**, J. Appl. Phys. **109**, 061301 (2011).
<https://doi.org/10.1063/1.3552291>