# Dr. Abhishek Singh
# High-field and broadband photoconductive THz sources

Photoconductive (PC) terahertz (THz) sources are widely used in THz spectroscopy, imaging, and ultrafast photonics. However, their performance is often limited by low THz output power and spectral bandwidths restricted to below 7 THz. In this work, we discuss the key challenges, such as bias field breakdown, pump power saturation, and material constraints, faced by PC THz sources, and approaches to overcome them. High-bias field operation of GaAs-based emitters is enabled by suppressing unnecessary currents through carbon ion irradiation and series resistance techniques. High pump energy/power operation is realized using large-area emitter designs with interdigitated electrodes, supporting μJ–mJ excitation levels. With these strategies, THz fields exceeding 230 kV/cm are achieved, and nonlinear THz effects are demonstrated using GaAs PC sources.

Beyond conventional III–V materials (GaAs and InGaAs), we highlight the emergence of germanium (Ge) as a next-generation photoconductive material, offering unique advantages of broadband THz emission and compatibility with a wide range of pulsed lasers spanning <800 nm to 1550 nm. Experimental demonstrations show gapless emission extending up to 70 THz, representing a substantial progress beyond the ~7 THz limit of conventional PC sources. Moreover, THz emission and detection from Ge-on-Si devices have been demonstrated, opening a scalable pathway toward low-cost, broadband, and integrable THz platforms. These results establish Ge-based PC THz devices as promising candidates for next-generation ultrafast THz technologies, combining compatibility with both high-power 1 μm lasers and economical 1550 nm fiber lasers, broad spectral coverage, and seamless Si-CMOS integration potential.

**Biography**

Dr. Abhishek Singh is a Ramanujan Faculty Fellow at the Centre for Advanced Electronics, IIT Indore, India and Founder-Director of THz-Innovations Pvt. Ltd., a startup company developing semiconductor-based terahertz (THz) devices and high-speed optoelectronics. He earned his Ph.D. in Physics from TIFR Mumbai, India and completed a prestigious Helmholtz Postdoctoral Fellowship at HZDR Dresden, Germany.

With over a decade of experience in THz photonics, ultrafast optics, and semiconductor device fabrication, Dr. Singh has pioneered techniques for broadband THz emitters, achieving record 70 THz gapless bandwidth and high-field THz generation. His research spans simulation, fabrication, and characterization of photoconductive devices and their applications.

He has authored 20+ peer-reviewed publications, holds patents in THz device technology, and has been honoured with awards including the Helmholtz Postdoc Fellowship and the URSI Young Scientist Award.