

Dr. Pankaj Kumar Sahoo

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RESEARCH EXPERIENCE

- **University of York, UK** **Apr 2022 – July 2023**
Photonics Group, School of Physics, Engineering and Technology.
Position: Postdoctoral Research Associate
Project: Immuno Diagnostix (IDX) - An ultrasensitive, low-cost photonic biosensor.
Sponsor: Engineering and Physical Sciences Research Council (EPSRC), UKRI
Responsibility: Theory, Modelling, and Fabrication of guided-mode-resonance-based photonic biosensor.
- **Swiss Federal Laboratories for Materials Science and Technology, Switzerland** **Mar 2021 – Mar 2022**
Laboratory of Advanced Material Processing (LAMP)
Position: Scientist
Project: In situ monitoring in laser additive manufacturing of metals and alloys based on artificial intelligence.
Sponsor: Swiss National Science Foundation.
Responsibility: Development of Fibre Bragg gratings (FBG) sensors for Acoustic Emission (AE) detection during laser additive manufacturing. Photonic Band-gap engineering and fabrication of FBGs on specialised optical fibres by excimer laser (193 nm) interference.
- **Rochester Institute of Technology, USA** **May 2019 – Sep 2020**
Chester F. Carlson Center for Imaging Science (CIS)
Position: Post-Doctoral Research Associate
Projects: Ultrafast laser-based material processing.
1. Femtosecond laser waveguide writing in Nd: YAG crystal: Design and Demonstration.
Sponsor: NASA Small Business Technology Transfer Program.
Responsibility: Fs-laser writing of Type I, Type II, and Type III waveguides in Nd: YAG crystals for waveguide lasing.
2. Femtosecond laser welding/bonding.
Sponsor: Lawrence Livermore National Laboratory, CA, USA
Responsibility: Modelling of femtosecond pulse through transparent materials, fs-laser bonding of uniform and patterned transparent/metal substrates.
- **Nanyang Technological University, Singapore** **Oct 2017 – Apr 2019**
Centre for Optical and Laser Engineering (COLE), School of Mechanical and Aerospace Engineering.
Position: Post-Doctoral Research Fellow
Sponsor: PFSAP, Panasonic, Singapore
Projects: Resonant Photonic Crystal structure and applications.
Responsibility:
 - Theory and experiment on graphene embedded guided-mode resonant structure for optical sensing and light-trapping.
 - Fabrication of sub-wavelength resonant grating structure by interference lithography and fs-laser writing.
 - Modelling of fs pulse interaction with polyimide for optimizing laser-induced graphene fabrication process.
- **Royal Institute of Technology (KTH), Stockholm, Sweden** **Oct 2013 – Oct 2014**
Electrum Laboratory, School of Information & Communication Technology, Kista.
Position: Erasmus Mundus (India4EU II) Research Fellow
Sponsor: European Union
Project: Si-based photonic crystal structures: Theory, Fabrication, and Applications.
Responsibility:
 - Modeling and fabrication of a correlated disorder pattern of Si nanopillars embedded in the PDMS matrix for its application as transmission color filters in display devices and image sensors.
 - Modeling and fabrication (hydrothermal growth) of ZnO nano-funnel structures through hexagonally patterned hole array on Si substrate for photovoltaic applications.
 - Bandgap engineering of 3D inverse opal photonic crystals.

COLLABORATIVE RESEARCH EXPERIENCE

- **University of York, UK.** **July 2023 – Present**
Photonics Group, School of Physics, Engineering and Technology.
Responsibility: Theory, Modelling, and Fabrication of guided-mode-resonance-based photonic biosensor.
- **Indian Institute of Technology Delhi (IITD), India** **Continuing**
Collaborative post-doctoral researcher from 01 Oct 2020 to 28 Feb 2021 with Prof. Joby Joseph at the Dept. of Physics at the Indian Institute of Technology Delhi, India.
Responsibility: Theory and modelling of guided-mode resonance structures, writing publications.
- **Indian Institute of Technology Kharagpur (IITKGP), India.** **Continuing**
I have worked on Hybrid Plasmonic Waveguide (HPW) based directional couplers in collaboration with Prof. Partha Roy Chaudhuri at the Dept. of Physics at the Indian Institute of Technology Kharagpur, India.
Responsibility: FDTD modelling and theoretical work on designing a stable hybrid plasmonic directional coupler based on an embedded silver nanostructure.
- **Paul Scherrer Institute (PSI), Switzerland** **Mar 2021 – Feb 2022**
Swiss Light Source (SLS)
Responsibility: Experimental setup for detection of the acoustic wave and electromagnetic waves generated when laser, neutron, and X-ray beam interacts with Titanium, stainless steel, and bulk metallic glass.

EDUCATION

- **Doctor of Philosophy** **21 Jul 2012 – 26 Oct 2017**
Indian Institute of Technology Delhi, India
Photonics Research Laboratory, Department of Physics
 - **CGPA in Course Work:** 10.00/10
 - **Supervisor:** Prof. Joby Joseph
 - **Thesis:** Light manipulation in photonic crystal structures and their applications.
This Ph.D. thesis is concerned with the design, fabrication, and use of periodic and aperiodic photonic crystal structures (1D as well as 2D) for various photonic applications. The photonic crystal structures are designed and analysed by FDTD modelling and fabricated by interference lithography, electron beam lithography, and the relevant semiconductor processes such as PECVD and ICP etching. Guided mode resonance (GMR) structures have been researched in detail and a new concept has been proposed to tune the GMR peaks by azimuthal rotation of the GMR device. A highly sensitive optical sensor has been developed based on the phase measurement of the GMR signal using a laser-tuned Mach Zehnder interferometer. A novel concept of color filters for display and image sensors has been proposed based on the aperiodic assembly of Si nanopillars embedded in the PDMS matrix. A new light-trapping technique has been proposed and developed for reducing reflection loss as well as for light focusing on submicron scales in Si-solar cells by hexagonal arrays of ZnO-funnel-like structures by patterned growth (hydrothermal) of ZnO nanowires. 2D Si photonic crystal structures with embedded defects have been proposed for various optical circuit components.
- **Master of Technology (Applied Optics)** **Jul 2010 – Jun 2012**
Department of Physics, Indian Institute of Technology Delhi, India
 - **CGPA:** 9.00/10
 - **Project thesis:** Photonic Crystals for Optical Circuits.
This master's thesis involves the theoretical study of photonic crystal structures and their properties. Different fabrication techniques with special emphasis on direct laser writing (DLW) and laser interference lithography (LIL) have been described. Detailed analysis of all kinds of photonic crystal defects along with their applications has been elucidated. Numerical demonstration of photonic crystal structures as various functional elements such as logic gates for photonic ICs has been provided.
 - **Major Optics Courses:** Semiconductor Optoelectronics, Optical Electronics, Laser Systems and Applications, Fourier Optics and Information Processing, Theory and Applications of Holography, Fiber Optics, Information Display Devices and Technology, Optical Sources Detectors and Photometry, Optical System Designing, Optical Instruments, and Metrology.
 - **Lab experiments performed:** Spatial Filtering and Fourier optics, Abbe Refractometer, Strain viewer photoelasticity, Holography, Spackle optometry, Interferometry, Display devices, Fiber optics.

➤ **Master of Science (Physics)**

Jun 2008 – Jun 2010

Department of Physics, Utkal University, Bhubaneswar, India

- **Special Paper:** Solid State Physics
- **Rank:** 3rd topper in the university with 77.5%
- **Major Courses:** Quantum Mechanics, Condensed Matter Physics, Mathematical Physics, Electrodynamics, Nuclear and Particle Physics, Classical Mechanics.

➤ **Bachelor of Science (Physics Honours)**

Jun 2005 – Jun 2008

Department of Physics, G. Sc. College, Utkal University, India

- **Rank:** 6th university rank and topper in the college with 75.75%

➤ **Class XII (88%), Class X (85.2%)**

Up to 2005

TEST SCORES

- CSIR National Eligibility Test (NET, June 2010) - All India Rank 29.
- Graduate Aptitude Test Engineering (GATE, 2010) - Score 415, All India Rank 280.

AWARDS AND FELLOWSHIPS

- **Erasmus Mundus (India4EU II) Fellowship** – 2013-14.
Exchange Ph.D. scholar at KTH, Sweden.
- **Institute of Mathematics Scholarship** – 2008-10.

RESEARCH ACCOMPLISHMENTS

- 'Nature Scientific Reports, Vol. 7, 7607 (2017) publication has been included as **part of the book chapter**: "W. Zhou and S. Fan, Photonic Crystal Meta surface Optoelectronics (Academic Press, 2019), Vol. 101, p. 246".
- **Editor's pic** for the publication "Optics Letters, Vol. 44, No. 15, 3661-3664 (2019)".
- 1st prize for poster presentation at the INTOPMAA-17, 11-13 Aug 2017, IIST Trivandrum, Kerala, India.
- Best poster presentation at SRC presentation, May 2016, Department of Physics, IIT Delhi, New Delhi, India.
- Best poster presentation at the XXXVII National Symposium of Optical Society of India, 23-25 Jan 2013, Pondicherry University, India.

SKILLS AND EXPERTISE

- **Theoretical Expertise:** Optics and Photonics, Photonic Crystals, Guided Mode Resonance, Lasers, Surface Plasmon Resonance, Fibre Bragg Grating.
- **Simulation Skills:** MATLAB, FDTD solutions (Lumerical and MEEP), MPB (MIT Photonic bands).
- **Experimental Skills:** Fibre Bragg Grating (FBG) inscription using Excimer laser, Laser Interference Lithography, fs-laser waveguide writing and bonding, Waveguide lasing, Embedding silicon nano-pillars in PDMS, Hydrothermal growth of ZnO nanowires on Si substrate, Graphene transfer.
- **Clean Room Nanofabrication Skills:** Nano Imprint Lithography (NIL), RIE (Reactive Ion Etching), ICP (Inductively Coupled Plasma Etching), PECVD (Plasma Enhanced Chemical Vapor Deposition), Wet Etching, e-Beam lithography, Photolithography.
- **Characterization Skills:** SEM (Scanning Electron Microscope), Confocal Laser Microscopy, Optical Spectrum Analyzer, Spectrophotometer, Optical 3D Profilometer.
- **Reviewing Skills:** Reviewed scientific papers for high-impact journals (Nature Scientific Report, Optics Letters, Optics Express, IEEE Sensors, Applied Optics, Journal of Modern Optics, etc.).

PROFESSIONAL CERTIFICATIONS

- Certified Training on "Optical System Design and Illumination Analysis" from OSLO and TracePro, 12-13 Nov 2011.

INVITED TALKS

- IIT Delhi Student Chapters of OSA & SPIE, 11 June 2021, Department of Physics, IIT Delhi.

GRANT WRITING EXPERIENCE

- **JSPS Fellowship (Japan) - 2019**

Proposal: Holographic optomechanical guided-mode-resonant sensors using photopolymerizable nanocomposite materials.

Responsibility: Primary applicant with host Prof. Yasuo Tomita, University of Electro-Communications, Japan.

Result: Rank A (top 20%) among A-C for unaccepted submissions.

- **Alfred P. Sloan Grant (USA) - 2019**

Proposal: Sensor technologies to monitor energy or environmental systems.

Responsibility: Primary applicant with PI Prof. Jie Qiao, RIT, USA.

Result: Not awarded

- **Extra Mural Research Funding (India) - 2017**

Proposal: Study and fabrication of high sensitivity Guided-mode-resonance optical sensor employing phase detection.

Responsibility: Co-authored with PI Prof. Joby Joseph, IITD, India.

Result: Awarded

THESIS MENTORED

Name of Scholar	Registration Number	Title of Thesis	Program	Year	University
Nicholas C Y Tham	G1602881J	Investigations into femtosecond laser hybrid manufacturing for 3D power sources	Doctorate	Completed Jun 2021	NTU, Singapore
Jian Yi Pae	G1602726D	Investigations into optical biosensors in visible-NIR wavelength band for disease detection applications	Doctorate	Completed Apr 2021	NTU, Singapore
Gokulnath Rajendran	G1700570J	Opto-Mechatronics instrumentation of a specialty optical fiber-based optogenetic probe	Master's	Completed 2019	NTU, Singapore
Leong J Y Joseph	U1522479E	Investigation into surface plasmon resonance-based optical sensor	UG	Completed 2019	NTU, Singapore

PATENTS

1. US patent: "A Method and an apparatus for manufacturing a porous graphene layer across a precursor material layer on a substrate through thermally localized laser graphitization", N. Tham, Pankaj K. Sahoo, V. M. Murukeshan, Y.J. Kim & M. J. Low. Application no 17798854, Date of Publication: 23 March 2023.
2. Indian patent: "An Optical Transmission Filter", B. D. Choudhury, A. Srinivasan, and Pankaj K. Sahoo. Application no. 201827001031, filing date: 10 January 2018.

JOURNAL PUBLICATIONS

1. J. Nayak, P. R. Chaudhuri, Pankaj K. Sahoo, "Stable Hybrid Plasmonic Directional Coupler based on an Embedded Silver Nanostructure waveguide", **Applied Optics**, Vol. 60, No. 25, 7603-7610 (2021).
2. N. Tham, Pankaj K. Sahoo, Y A Kim, C Hegde, S. W Lee, Y J Kim & V M Murukeshan, "Thermally controlled in-situ formation of localized porous graphene for integrated graphene-paper electronics", **Advanced Materials Technologies** Vol. 6, No. 5, 20011561-13 (2021). **(Co-first author)**

3. Pankaj K. Sahoo, J. Sharma, R. Yukino, A. Sandhu, and J. Joseph, "High azimuthal angle tolerant dual-channel wavelength filter from visible to NIR using conically mounted guided-mode resonance structures," **Optics Letters**, Vol. 45, No. 22, 6010-6013 (2020).
4. Pankaj K. Sahoo, T. Feng, and J. Qiao, "Dynamic pulse propagation modelling for predictive femtosecond-laser-micro bonding of transparent materials," **Optics Express**, Vol. 28, No. 21, 31103-31118 (2020).
5. T. Feng, Pankaj K. Sahoo, F. R. Arteaga-Sierra, C. Dorrer, and J. Qiao, "Pulse-Propagation Modeling and Experiment for Femtosecond-Laser Writing of Waveguide in Nd: YAG," **Crystals** 9(8), 434 (2019).
6. J. Y. Pae, Pankaj K. Sahoo, and M. V. Matham, "Grating-coupled plasmonic sensor for sucrose sensing fabricated using optical fiber-based interference lithography (OFIL) system," **IEEE Sensors Journal**, Vol. 19, 10477-10481 (2019).
7. Pankaj K. Sahoo, J. Y. Pae & V. M. Murukeshan, "Enhanced absorption in a graphene embedded 1D guided-mode-resonance structure without back-reflector and interferometrically written gratings", **Optics Letters**, Vol. 44, No. 15, 3661-3664 (2019).
8. N. Tham, Pankaj K. Sahoo, Y J Kim & V M Murukeshan, "Ultrafast volume holography for stretchable nanoscale structures", **Optics Express**, Vol. 27, No. 9, 12196-12211 (2019). **(Co-first author)**
9. S. Sarkar, S. Poulouse, Pankaj K. Sahoo & J. Joseph, "Flexible and stretchable guided-mode resonant optical sensor: single-step fabrication on surface engineered polydimethylsiloxane substrate", **OSA Continuum**, Vol. 1, No. 4, 1277-1286 (2018).
10. Pankaj K. Sahoo, S. Sarkar & J. Joseph, "High sensitivity guided-mode-resonance optical sensor employing phase detection", **Nature Scientific Reports**, Vol. 7, 7607 (2017).
11. Pankaj K. Sahoo, B. D. Choudhury, J. Joseph, and S. Anand, "ZnO nanowire-enabled light funneling effect for antireflection and light convergence applications ", **Optics Letters**, Vol. 42, No. 1, 45-48 (2017).
12. R. Yukino, Pankaj K. Sahoo, J. Sharma, T. Takamura, J. Joseph, and A. Sandhu, "Wide wavelength range tunable one-dimensional silicon nitride nano-grating guided-mode resonance filter based on azimuthal rotation, **AIP Advances** 7, 0153131-6 (2017).
13. Pankaj K. Sahoo, J. Joseph, R. Yukino, and A. Sandhu, "High sensitivity refractive index sensor based on simple diffraction from phase grating", **Optics Letters**, Vol. 41, No. 9, 2101-2104 (2016).
14. B. D. Choudhury, Pankaj K Sahoo, R. Sanatinia, G. Andler, S. Anand, and M. Swillo, "Surface second harmonic generation from silicon pillar arrays with strong geometrical dependence", **Optics Letters**, Vol. 40, No. 9, 2072-2075 (2015).
15. Pankaj K. Sahoo & J. Joseph, "Optical diode using nonlinear polystyrene ring resonators in two-dimensional photonic crystal structure", **Applied Optics** Vol. 52, No. 34, 8252-8257 (2013).

SUBMITTED/IN-PREPARATION

16. S. Bakshi, Pankaj K. Sahoo, K. Li, S. Johnson, M. J. Raxworthy, and T. F. Krauss, "Nanophotonic and hydrogel based theranostic system for the monitoring of chronic wounds", Under review, **Biosensors and Bioelectronics** (2023).
17. S. Sarkar, S. Devinder, Pankaj. K. Sahoo, and J. Joseph, "Tunable single-wavelength detection schemes for guided-mode resonance sensors ", Under review, **Advanced Optical Materials** (2023).
18. Pankaj K. Sahoo, E. Coates, C. D. Silver, K. Li, and T. F. Krauss, "Full tolerant design of resonant grating sensors", Preparing to submit in **Chemical Sensors** (2023).
19. Pankaj K. Sahoo, J. Sharma, R. Yukino, A. Sandhu, and J. Joseph, "Angle insensitive 1D guided-mode-resonant wavelength filter under conical diffraction: Theoretical formulation and realization", Preparing to submit in **Optics and Laser in Engineering** (2021).
20. B. D. Choudhury, Pankaj K. Sahoo, J. Joseph, and S. Anand, "Nanopillar Assemblies with Deterministic Correlated Disorder for Color Filtering", preparing to submit to **Nano Letters** (2023). **(Co-first author)**.

CONFERENCE PROCEEDINGS

1. Pankaj K. Sahoo, K Li, T F Krauss, "Consistency Study of Guided-Mode-Resonance Structures for Point-of-Care Applications", in Conference on Optics, Photonics, and Quantum Optics (*COPaQ*), 2022, IIT Roorkee, India.
2. R. Scott, Z. Guo, Pankaj K. Sahoo, C. Dorrer, T. Feng, J. Qiao, "Comparison of Femtosecond Laser Welding of Transparent Materials at 1030 and 515 nm", in Conference on Lasers and Electro-Optics (*CLEO*), OSA Technical Digest (Optical Society of America, 2021), paper ATH2R.2.
3. R. Scott, Z. Guo, Pankaj K. Sahoo, C. Dorrer, T. Feng, J. Qiao, "Predictive ultrafast-laser-enabled microwelding using dynamic pulse propagation modelling", Laser Applications in Microelectronic and Optoelectronic Manufacturing (LAMOM) XXVI, International Society for Optics and Photonics: (*SPIE*, 2021), Vol. 11673, Pages 116730M.
4. J. Qiao, T. Feng, Pankaj K. Sahoo, S. Patra, R. Haque, and C. Dorrer, "Ultrafast-Laser-Enabled Micro welding and Waveguide Inscription for Optics and Laser Fabrication," in *Laser Congress 2020 (ASSL, LAC)*.
5. J. Qiao, T. Feng, Pankaj K. Sahoo, and G. Chen, Ultrafast-laser-enabled Polishing, and Waveguide Writing for Optics and Microchip Laser Fabrications, *SPIE Laser Damage (SPIE, 2020)*, Vol. 11514.
6. Pankaj K. Sahoo, T. Feng, M. Sharma, G. Kessel, S. Patra, R. Haque, and J. Qiao, "Dynamic modelling for predicting temperature evolution and modification during fs-laser welding of borofloat glass," in Conference on Lasers and Electro-Optics (*CLEO*), OSA Technical Digest (Optical Society of America, 2020), paper ATu3K.2.
7. T. Feng, Pankaj K. Sahoo, F. R. A. Sierra, C. Dorrer, J. Qiao, "Nonlinear femtosecond pulse-propagation simulation and experiment for laser-based-waveguide-writing in crystal materials", *SPIE*, Laser Applications in Microelectronic and Optoelectronic Manufacturing (LAMOM) XXV, 11267-41, 3 - 5 February 2020, San Francisco, California, USA.
8. Pankaj K. Sahoo, Swagato Sarkar & Joby Joseph, "Phase measurement of guided-mode-resonance signal and its application as highly sensitive optical sensor", International topical meeting on applied and adaptive optics (*INTOPMAA-17*), 11-13 Aug 2017, IIST Trivandrum, Kerala, India.
9. Pankaj K. Sahoo & Joby Joseph, "Compact wavelength division multiplexer using nonlinear polystyrene cavities in 2D photonic crystal structure", *Metamaterials and Photonic Nanostructures – 2013*, 16-17 Aug 2013, I.I.T. Kanpur.
10. Pankaj K. Sahoo & Joby Joseph, "Optically Controlled Wavelength Division Multiplexer using Nonlinear Asymmetric Cavity in 2D Photonic Crystal", XXXVII National Symposium of *Optical Society of India*, 23-25 Jan 2013, Pondicherry University, India.