

Curriculum Vitae

PERSONAL INFORMATIONS

Ummer K. V, PhD

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Sex: Male | Date of birth: 23/03/1983 | Marital status: Married | Nationality: Indian

RESEARCH INTEREST

Few of my research interests are of following-

Nano-photonics, Nano-plasmonics, Silicon photonics, Biophotonics, Quantum photonics, Photonic crystal slab based - light emitting diodes (LEDs), Photovoltaics or Solar Cells, applications based on confining light in wavelength scale, narrowband Optical Filters and Sensors.

RESEARCH/TEACHING EXPERIENCE

March 2019
– July 2020

POST-DOCTORAL RESEARCH ASSOCIATE

**Centre for Nanoscience and Engineering (CeNSE), Indian Institute of Science (IISc) Bangalore,
Bangalore-560012, India**

- Experience in modeling on photonic crystal **resonant cavities - Bound state in continuum (BIC)** resonant modes in photonic crystal slab.
- Expertized in the **Nano-fabrication** of high quality 2D **photonic and plasmonic structures** by **Electron Beam Lithography (EBL)**.
- Rich experience in **Class-100 and Class-1000 clean room**.

Oct 2021 –
Jan 2022

GUEST LECTURER in PHYSICS

Malabar Christian College, Calicut, Kerala, India

Jan 2022- Till
Present

ASSISTANT PROFESSOR (CONTRACT) in PHYSICS

Kelappaji College of Agricultural Engineering and Technology (KCAET), Tavanur , India

EDUCATION

Aug 2010 –
Aug 2018

DOCTOR OF PHILOSOPHY in PHYSICS, Research Area: NANOPHOTONICS

Indian Institute of Technology Kanpur (IIT K), Kanpur- 508016, India

Thesis Title: *Role of Band-edge Modes and In-plane Modes in Two- and Three- dimensional Photonic Crystals.*

Thesis Supervisor: Prof. R. Vijaya

2006-2008

MSc in Physics

Mahatma Gandhi University, Kottayam, Kerala, India

Specialization: Electronics

Percentage of mark obtained: 70%

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2002-2005 **BSc in Physics**

University of Calicut, Calicut, Kerala, India

Subjects: Physics (main), Mathematics and Chemistry (subsidiaries)

Percentage of mark obtained: 84.8%

2002 **Plus Two in Science**

Board of Higher Secondary Examination, Govt. of Kerala, Kerala

Subjects: Physics, Mathematics, Chemistry, Biology

Percentage of mark obtained: **65.4%**

2000 **S. S. L. C**

Board of Public Examination, Govt. of Kerala, Kerala

Percentage of mark obtained: **77.8%**

NATIONAL LEVEL TESTS QUALIFIED

- Secured **All India 5th rank** in **GATE-2010** (Graduate Aptitude Test in Engineering) in physical science.
- Qualified **UGC-JRF-NET** held in Dec. 2009 and June 2012. Passed JEST (Joint Entrance Screening Test) 2010 with 99 percentiles.

SKILLS AND EXPERIENCE

- Hands-on experience with **vertical and horizontal self-assembly** of colloidal nanoparticles, and **Focused Ion Beam (FIB)** milling
- Hands-on experience with cleanroom **chemical wet benches** - Piranha cleaning, RCA 1 and RCA 2 cleaning etc.
- Experience in **modelling** and hands-on **experimental skills** on 2-D and 3-D photonic crystals.
- Expertized as **independent user** in using machines –
 - EBL- **Raith e-LiNE**, EBL – **Raith Pioneer**
 - Reactive Ion Etching-Oxford(OI) (**RIE-F**, **RIE-CI**), **PECVD-Oxford(OI)**
 - Ultra55 **FESEM** Karl Zeiss **EDS**, Ellipsometer, spin coater, confocal optical microscope, **Olympus IX71 Inverted fluorescence microscope**.
 - **UV-Vis-NIR spectrophotometer**, Optical spectrum analyzer (OSA), Integrating sphere, surface profilometer, **Nd:YAG laser**, Time co-related single photon counting (TCSPC) system for measuring fluorescent decay time.
- Experience in **Tecport Sputter deposition and e-beam evaporation** tool for metal.
- Hands-on experience with optical modeling tools like **RSoft** modules - such as BandSOLVE (PWE), FullWAVE (FDTD), DiffractMOD (RCWA), LED Utility, Solar Cell Utility, LaserMOD, GratingMOD, **Lumerical**, and **COMSOL Multiphysics**. Programming skills in **MATLAB** and **Python**.

PUBLICATIONS

Publications in peer reviewed journals

1. **K.V. Ummer** and R. Vijaya, "Photonic band-edge-induced enhancement in absorption and emission," *J. Nanophoton.*, vol. 9, no. 1, p. 093086, 2015.

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2. **K. V. Ummer** and R. Vijaya, "All-angle negative refraction effects and subwavelength imaging in photonic crystals with honeycomb lattice," *J. Nanophoton.*, vol. 11, no. 3, p. 036005, 2017.
3. **K. V. Ummer** and R. Vijaya, "Spectral characterization of silicon photonic crystal slab using out-of-plane light Coupling arrangement," *Appl. Phys. B*, vol. 124, no. 7, p. 136, 2018.

Work presented at international conferences:

1. 3rd Int. Conf. on Nanosci. & Nanotech. - ICONN 2015, SRM University, Chennai, Feb. 4-6, 2015, "Photonic band edge induced enhancement in absorption and emission" by **Ummer K. V.** and R. Vijaya. (Oral presentation).
2. The 9th Int. Conf. on Nanophoton. - ICNP 2016, Taipei, Mar. 21-25, 2016, "Broadband negative refraction in a two-dimensional photonic crystal without any negative index material" by **Ummer K. V** and R. Vijaya. (Oral presentation).
3. 13th Int. Conf. Fibre Opt. Photonics - PHOTONICS 2016, IIT Kanpur, Dec. 5-8, 2016, "Broadband All-angle Self-collimation from Photonic Crystals with Rectangular Symmetry", by **Ummer K. V** and R. Vijaya. (Poster presentation).
4. Adv. Photonic Congress-2017, Louisiana, New Orleans, USA "Characterizing Fano Resonances from Si Photonic Crystal Slab Using Out-of-plane Light Coupling Arrangement," **Ummer K. V** and R. Vijaya. (Selected for poster presentation but couldn't present).

RESEARCH WORK (IN BRIEF) DURING PHD

The periodic dielectric media with a periodicity of the order of wavelength are called photonic crystals (PCs). The bandgap feature and the band edge modes in three-dimensional (3-D) PCs has been exploited for studying the **absorption and emission enhancement** of the embedded emitters. The **negative refraction effect and self-collimation effect** has been studied from 2-D PCs. In addition, the **Fano resonance** from PC slab fabricated by EBL has been analyzed experimentally. The work done during Ph.D course is following.

1. Modeling and experimental study on absorption and emission enhancement of RhB-dye from 3D PC environment

- **Achieved a maximum of 70% enhancement** in spontaneous emission over the intrinsic emission of RhB dye by photonic **band-edge induced absorption and emission**.
 - ✓ The lower group velocity photonic band-edge modes provide an increased light-matter interaction time which can be exploited to design **low-threshold tunable band-edge lasers**.
 - ✓ Through a band-edge induced light absorption the photocurrent in **solar cells** can be increased and hence their efficiency.
- Fabricated 2-D PC structure on Silicon wafer with square, hexagonal and honeycomb lattice symmetry using **FIB machine**

2. Hands-on experience with Modeling and Experimental work on 2-D PC Slab (PCS)

- Fabricated high quality **2-D PCS** using SOI wafer by **e-beam lithography**.
- Optically characterized the radiation (leaky) modes by **out-of-plane light-coupling experimental set-up**.

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- The **Fano resonance** associated with the leaky modes of the slab has been studied, and analyzed their quality factors.
 - ✓ The quality factors can be tuned by adjusting the hole diameter. This can be exploited to increase the **external quantum efficiency** of **LEDs** and to design **low-threshold surface emitting lasers**. The resonant modes also can be used for **sensing** applications.
- 3. **Hands-on experience in modeling the equi-frequency contours to study different dispersion phenomenon from 2D PCs**
 - ❖ **All-angle (± 90 deg) Negative Refraction (AANR) effects**
 - Proposed AANR with a broader **bandwidth of $\sim 23\%$** .
 - Proposed a **polarization independent AANR effect**.
 - Also proposed a polarization independent **Dual Negative Refraction (DNR)** effect.
 - Achieved a **sub-wavelength resolution of $\sim 0.2\lambda$ in imaging** with PC super-lens.
 - ✓ The sub-diffraction imaging using PC might revolutionize the optical technologies to make microcircuits using optical lithography well in the nanometre scale and also increasing the data storage capacity in the digital video disc (DVD).
 - ❖ Proposed the all-angle (± 90 deg) **Self- Collimation effect** (where the light can propagate without having any diffraction in the lateral direction) with a bandwidth of 15%.

OTHER INFORMATIONS

- Received **Best Innovative Research Award** for the oral presentation in 3rd Int. Conf. on Nanosci. & Nanotech. - ICONN 2015, SRM University, Chennai, 2015.
- ❖ **Teaching Assistantship at IITK:** *Course-PHY101* (UG physics lab) for six semesters, *Course-PHY103*—General physics (Electrodynamics) for one semester, *Course-PHY399* (Technical communication) for two semesters.
- ❖ **Reviewer** in Journal of Optics - Springer.

REFERENCES

1. Prof. R. Vijaya, Dept. of Physics, IIT Kanpur, Kanpur-208016, U. P, India, Ph: 0512-259-7552, Email: rvijaya@iitk.ac.in
2. Prof. H. Wanare, Dept. of Physics, IIT Kanpur, Ph: 0512-259-7885, Email: hwanare@iitk.ac.in
3. Prof. Saikat Ghosh, Dept. of Physics, IIT Kanpur, Ph: 0512-259-6971, Email: gsaikat@iitk.ac.in
4. Prof. Ambarish Ghosh, Dept. of Physics, IISc Bangalore, Bangalore 560012, India, Ph: +91 80 2293 2442, Email: ambarish@iisc.ac.in