IITB-Monash Research Academy

Indian Institute of Technology Bombay | MONASH University

An Indian-Australian research partnership

Project title Photonic crystal antenna – design and fabrication

Project number: IMURA0159

Monash University supervisors: Assoc Prof. Malin Premaratne and Dr. Le N. Binh
Monash University contact: Dr. Malin Premaratne, malin.premaratne@eng.monash.edu.au

IITB supervisors: Dr. R.Vijaya, Professor
IITB contact: Dr. R.Vijaya, Professor; Email: rvijaya@iitb.ac.in

---

Research Academy theme/s 1,3, 5

List only the research academy theme/s that is relevant to the project

1) **Advanced computational engineering, simulation and manufacture**
2) Infrastructure engineering
3) **Clean energy**
4) Water
5) **Nanotechnology**
6) Biotechnology and stem cell research

The research problem

Photonic crystals are artificial structures with a periodic variation of refractive index. This periodicity can be in one, two, or three orthogonal directions resulting in 1-D, 2-D and 3-D photonic crystals. They are useful for controlling, manipulating and localizing the propagation of light. A complete photonic band gap results when the crystal shows an overlapping stop band for all angles of incidence of light and TE/TM polarizations. However, the presence of a pseudo-gap, where the transmission of a certain wavelength band is inhibited only in selected directions, is also useful in multiple applications.

The challenge in fabricating 3-D photonic band gap materials for visible and near-IR wavelength range can be overcome by the method of self-assembly. Active materials can be incorporated into the photonic crystals and their emission characteristics can be analyzed to design photonic crystal antennas. The study will involve experimental work of fabricating and characterizing the crystals as well as computational work on modeling their radiative characteristics.

Project aims

1. Fabricate active photonic crystals and characterize their photonic band gap property
2. Study the emission characteristics through laser-induced fluorescence measurements
3. Model and analyse the best design for photonic crystal antenna

Expected outcomes

1. The novel work can result in the capability to design miniature light-emitting devices for different applications
2. The resulting design can be integrated with solar cells to make compact modules with unique directional properties

Which of the above Theme does this project address?

1. Advanced computational engineering, simulation and manufacture
3. Clean energy
5. Nanotechnology

How will the project address the Goals of the above Themes?

The work will involve extensive computation on modelling the radiation properties of nanostructures. The work can be integrated in the future with clean energy alternatives such as solar energy devices. The structures to be studied in this work constitute photonic crystals for visible and near-IR wavelength range and have lattice constants of a few hundred nanometers.