Impact of fabrication disorder on slow-light photonic crystal waveguides

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Semiconductor-based planar photonic crystals are of great interest in nanophotonics due to their unique functionalities and their ease of fabrication using etching and lithography techniques. High-index-contrast photonic crystal structures exhibit many fascinating optical phenomena such as light trapping on sub-wavelength spatial dimensions and engineered waveguide mode dispersions with a vanishing group velocity. Yet, there remain considerable challenges in modeling and understanding real device structures as fabricated.

This talk will discuss the fundamental optical properties of slow-light photonic crystal waveguides and present what is now widely regarded as their biggest problem: “the disorder problem”. We will present practical methods that allow one to describe the light-matter processes over hundreds-to-thousands of unit cells, while accounting for nm-scale imperfections that are introduced at the fabrication stage. We will make a direct connection to state-of-the-art experiments and present a view of the future, connecting to novel applications such as Anderson Localization, slow-light enhanced nonlinear and quantum optics on a chip, and more robust design techniques that exploit Bloch mode nanoengineering.

Speaker Bio

Stephen Hughes is a full Professor in the Department of Physics, Engineering Physics and Astronomy, at Queen’s University, Kingston, Ontario. Prior to Queen’s, he was a Research Specialist at the prestigious NTT Basic Research Labs in Atsugi, Japan, and he carried out postdoctoral work at Philipps University Marburg (Germany), Tokyo University (Japan), and Washington State University (USA). He did his undergraduate studies and PhD work at Heriot-Watt University in Edinburgh, Scotland, where he is from. In 2003, he co-founded Lumerical Solutions Inc., a successful optical software and consultancy company based in Vancouver, BC, who specializes in delivering design solutions and computational tools for applications in nano-optics and nanophotonics. He also spent two years working for Galian Photonics Inc., a start-up company from University of British Columbia and a developer of integrated optical components enabled by photonic crystal technology. Dr. Hughes has extensive research experience in nanoscale semiconductor quantum optics, computational and theoretical optical materials science, advanced electromagnetic simulation, ultrafast laser-matter interactions and nonlinear optics. His research group at Queen’s has been focusing on the theory and applications of light-matter interactions in photonic nanostructures, contributing to both basic science and emerging nano- and quantum- technologies. His group enjoys strong collaborations with leading experimental and theoretical groups in Canada, Germany, France, New Zealand, and Japan.