

7. Conclusion

We have presented a theoretical analysis of guided resonances in PCS structures for biosensing. We discuss the differences between TE-like and TM-like modes, and their implications in bulk spectral sensitivity and resonance quality factors. We have reviewed the underlying physics and the engineering aspects in selecting a symmetric or asymmetric PCS topology. It is demonstrated that PCS biosensors suspended over a substrate (symmetric designs) can display roughly a three-fold increase in bulk sensitivity over slab-on substrate architectures (asymmetric designs) for TM-like guided resonances. Furthermore, we report that TM-like guided resonances have a stronger vertical field penetration than TE-like guided resonances, which contributes to their significantly higher bulk index sensitivity and to their potential to overcome major fabrication-related challenges in realizing high quality factors in large area PCS sensors. PCS sensors can have similar (TE-like) or smaller (TM-like) detection limits compared to existing optical biosensing techniques, with the added advantages of sensitivity optimization based on mode selection, and straight-forward sensor integration with microfluidics and optical readout by free space beams. Finally, analysis of modal field distributions suggest that TE-like resonance sensors may be suited for protein and biomolecule detection while TM-like resonance sensors are more meaningful for use to sense cells and large analytes.

Acknowledgements

The authors are grateful for the helpful discussions with O. Kilic and W. Suh during the early parts of this project. This work was supported in part through the University of Toronto departmental start-up funds to O. Levi, the Natural Sciences and Engineering Research Council of Canada (NSERC) Discovery Grant RGPIN-355623-08 and by the Networks of Centres of Excellence of Canada, Canadian Institute for Photonic Innovations (CIPI). V. Liu acknowledges partial graduate fellowship support by a Stanford Graduate Fellowship. Funding for M. El Beheiry was provided in part by the Ontario Graduate Scholarship Program and the Edward S. Rogers Sr. Graduate Scholarship.