Surface plasmon interferometer in silicon-on-insulator: novel concept for an integrated biosensor: Reply

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Abstract: We provide further details on the calculation method used in the paper "Surface plasmon interferometer in silicon-on-insulator: novel concept for an integrated biosensor" [Opt. Express **14,** 7063-7072 (2006)]. Contrary to the claims made in the Comment [Opt. Express **15,** 13649–13650 (2007)], the method used does take radiation modes into account and can therefore handle the recapture of optical power from these modes. Convergence studies are provided to support our calculations.

OCIS codes: (130.3120) Integrated Optics Devices; (130.6010) Sensors; (240.6680) Surface Plasmons

References and links

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4. P. Debackere, P. Bienstman, and R. Baets,"Improved ASR convergence for the simulation of surface plasmon waveguide modes," Opt. Quantum Electron. **38**, 857–867 (2006).
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1. Introduction

In the comment [2], the authors claim that the performance of the device we described in [1] will degrade once the recapture of power from radiation modes is taken into account. While it is true that we provided a simple physical explanation of the workings of the device based only on two guided modes, we do want to stress again that, as explicitly stated in section 4 of our original paper, all our numerical results for the sensitivity curves were obtained using full-wave calculations. Our method *does* take radiation modes into account, because we agree with the authors of the comment [2] that these must not be neglected.

#87823 - $15.00 USD Received 21 Sep 2007; revised 27 Sep 2007; accepted 1 Oct 2007; published 4 Oct 2007

2. Calculation method

Our sensitivity curves were obtained using an in-house developed full-wave eigenmode solver [3]. This method was briefly described in section 4 of our original paper [1], which also contained further references on the model [4]. To reiterate the points which are relevant for the current discussion, the method used is based on eigenmode expansion whereby the field is expanded as a linear combination of eigenmodes, both guided and radiation modes. To be able to calculate radiation loss accurately, the walls of the simulation domain are coated with Perfectly Matched Layers (PMLs) [5]. At the interfaces between the different waveguides, a scattering matrix approach is used which links all the modes in the simulation (both the guided and the radiation modes), so that recapture from radiation modes can be handled. This method was used successfully in the design of many devices where radiation modes play a crucial role, like e.g. grating couplers [6].

3. Convergence analysis

In the comment [2], the authors provide a counterexample which is supposed to illustrate the effects of radiation modes. However, the structure they study is different from the optimised one we presented in Fig. 6 of [1]), since the length of their device is 5.7 μm whereas the optimized device we have described has a length of 6.055 μm. As such, this counterexample does not prove any point. Also, we were unable to analyse this counterexample using our model, because in [2] and in our subsequent communication with the authors, they did not provide parameters (Silicon waveguide thickness) of the device. Therefore, in order to provide additional support for our calculations, we have chosen instead to provide a detailed convergence analysis of one of the structures we published in [1].

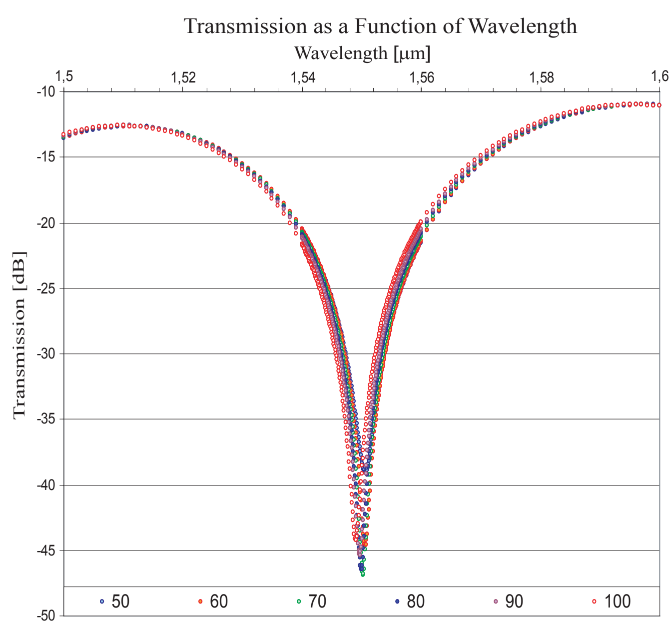

Fig. 1. Convergence Analysis

We will focus on the device with a *Si*-waveguide thickness of 101 nm, the corresponding

#87823 - $15.00 USD Received 21 Sep 2007; revised 27 Sep 2007; accepted 1 Oct 2007; published 4 Oct 2007

length of the sensing section is 6.055 μm. All other parameters can be found in [1]. To study the dependendce on the number of radiation modes we increased the number of modes in the simulation from 50 to 100 and follow the shape of the transmission spectrum. As can be seen in Fig. 1, once the number of modes is higher than 70, the shape of the transmission curve does not change significantly anymore.

It is also interesting to mention that the characteristics of this device were independently calculated by RSOFT with their software (FullWAVE) and similar results were obtained [7].

4. Conclusion

We agree with the authors of [2] that radiation modes can play an important role when studying a device. However, we did take them into account in our original paper.

#87823 - $15.00 USD Received 21 Sep 2007; revised 27 Sep 2007; accepted 1 Oct 2007; published 4 Oct 2007