Nano Scale Disruptive Silicon-Plasmonic Platform for Chip-to-Chip Interconnection

Design of 2nd generation beam shapers

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Executive Summary

In the first half of the project we focused on electrostatically moving grating couplers. For the second generation we focus on the design of grating couplers allowing to couple a transmitter and receiver chip through free space over distances from 0.1 to 1.0 mm. This work started with a high level design study, estimating the distance that can be expected and the form factor of the grating that should be used. The required grating coupler pitch increases from 50um for 100um chip to chip distance up to 100um for 1mm chip to chip distance, Next we developed an analytical formula for actually defining the focussing grating couplers. These are now under fabrication.

Change Records

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Contents

1. Introduction

In the first half of the project we focused on electrostatically moved grating couplers. For the second generation we focus on the design of grating couplers allowing to couple a transmitter and receiver chip through free space over distances from 0.1 to 1.0 mm. This work started with a high level design study, estimating the distance that can be expected and the form factor of the grating that should be used. Next we developed an analytical formula for actually defining the focussing grating couplers.

2. Summary of design

The pictures below summarize the results of the high level study. These figures show the different tradeoffs involved. For coupling over short distances it is better to use small grating couplers, which allow a reduced device pitch and broader wavelength operation (smaller gratings = stronger grating with less periods = broadband operation). However, these gratings have stronger diffraction and if coupling over larger distances is needed the size of the grating has to be increased to reduce diffraction and keep the device to device pitch minimal. However, the device to device pitch increases (along the black line for in figures below, for optimized case) and the optical bandwidth decreases. Figure 1 gives the case of a standard grating, whereby the light is directly diffracting as soon as it leaves the grating coupler. Figure 2 shows the case of using a focussing grating coupler, whereby the reachable chip-to-chip distance is roughly doubled. One can deduce that, e.g. for a chip-to-chip distance of 1mm, a grating pitch of at least 0.1mm is required.

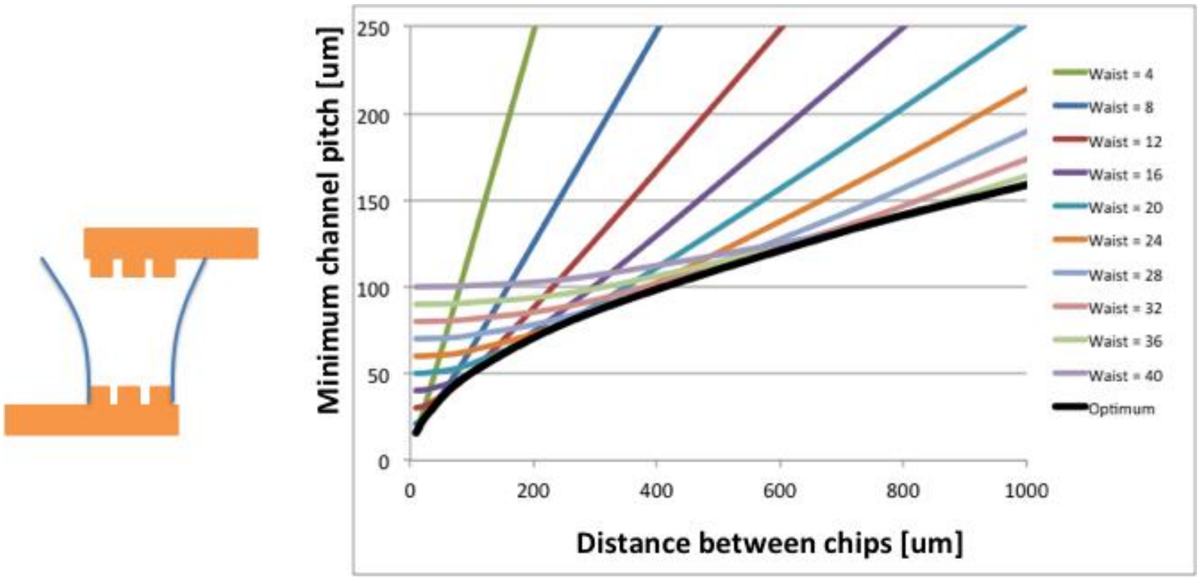

Figure 1 Minimum channel pitch as function of distance between chips for different initial grating sizes (grating size equal to beam waist)

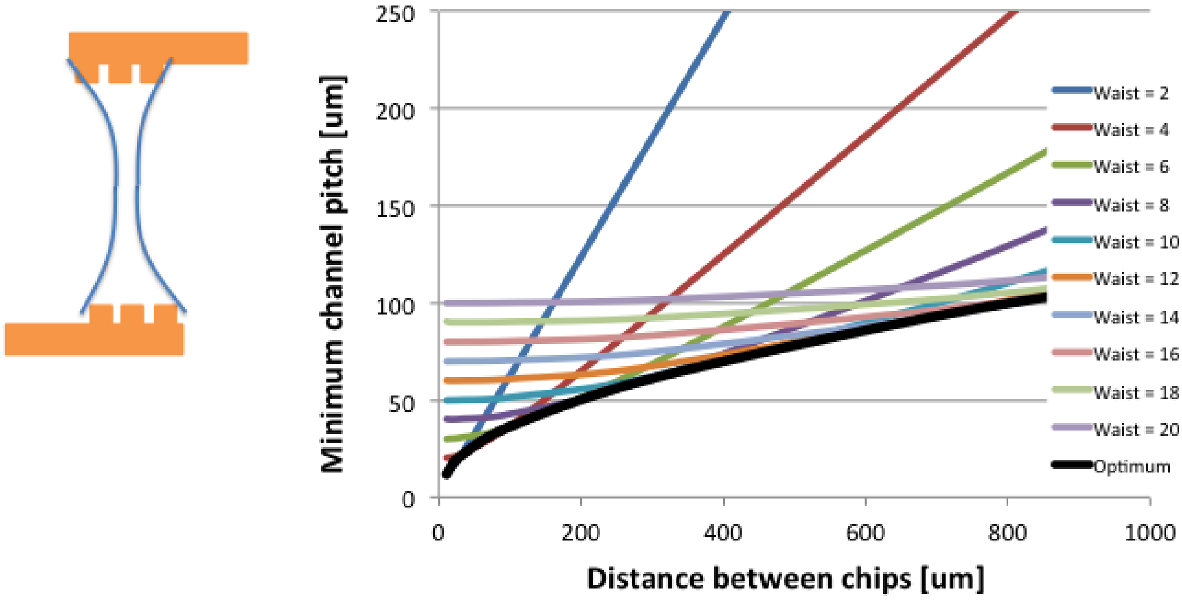

Figure 2 Minimum channel pitch as function of distance between chips for different initial grating sizes (focusing gratings)

Based on these results we then designed gratings aimed at coupling over distance of 0.1, 0.5 and 1.0mm total distance. Since these focussing gratings have a different size than our standard grating couplers optimised for fiber chip coupling an adapted etch depth is required, not available in the standard SOI process. Therefore unetched base structures were designed and are currently under fabrication at imec (Fig. 3). Following the initial etching step (waveguides, input grating), the actual focussing grating will be defined using ebeam lithography and a dedicated etching step.

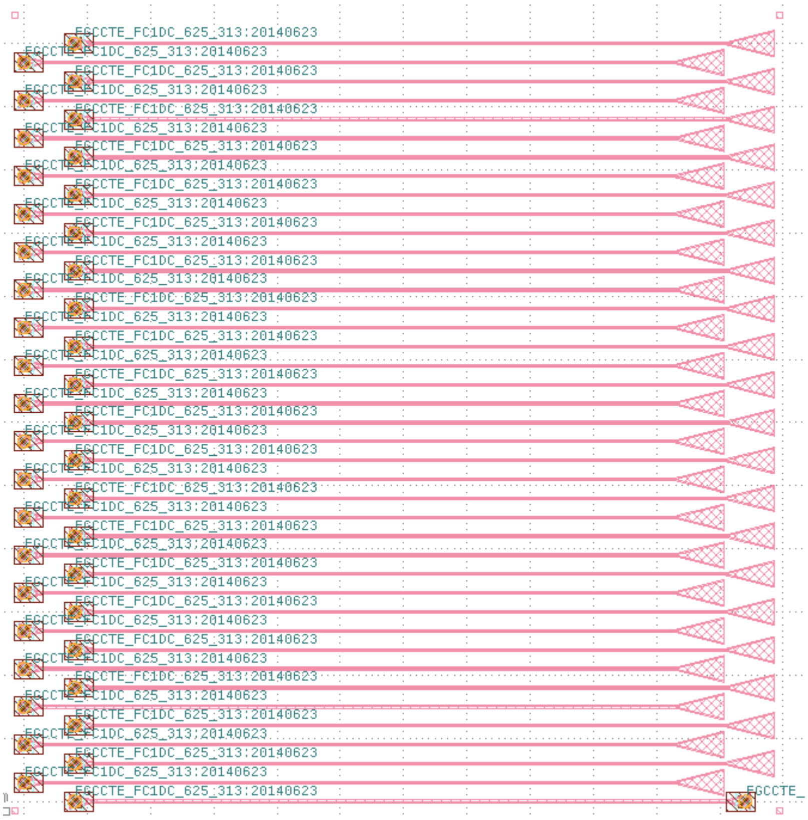

Figure 3. SOI base layer

3. Conclusion

We determined the trade-off between chip-to-chip distance and channel pitch in the case of standard and focussing grating couplers. We then designed a range of focussing grating couplers which are currently under fabrication.