Modelling of Mechanical Stability of a Thermo-optic Phase Shifter

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Modelling of Mechanical Stability of a Thermo-optic Phase Shifter

Master's Thesis Project

Public Summary

This report was made in accordance with the TU/e Code of Scientific Conduct for the Master thesis.

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Photonic devices have historically been produced on the InP platform due to its capability for integrating active devices like lasers. However, the InP platform is expensive and hence utilising the benefits of both the silicon and InP platform, hybrid integration offers a potential solution. Hybrid integration involves the placement of active devices from the InP wafer onto a silicon photonic wafer containing passive devices. To extract the active devices from the InP wafer, they need to be released from the wafer. This is achieved by selectively etching away a sacrificial layer between the waveguide and substrate using an etchant, effectively creating an air gap beneath the waveguide. Subsequently, the hard mask is removed, and during the final drying process, capillary forces exerted by the liquid can pin down the structure. To solve this issue, this study investigates the efficacy of various models for assessing the mechanical stability of suspended structures. An analytical model is developed and its limitations for edge cases are discussed. However, it remains a valuable tool for quickly identifying trends, making it a useful initial assessment method. Some mechanical stability experiments are compared with a numerical model, demonstrating the significant impact of different orientations of structures within the wafer on mechanical stability, due to an anisotropic etching step in the production process. While a good agreement between experiments and numerical simulation is achieved, some discrepancies require further investigation as the numerical model seems to underestimate the stability consistently compared to experiments. Furthermore, the numerical model is utilized by optimising the positions of connections which hold the active devices in place. These optimised positions provide substantial increases in the stiffness of suspended structures without requiring any additional material.