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Simulation of Plasmonic Waveguides Based on Long-range Surface Plasmon Polaritons

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ABSTRACT

The demand for faster and smaller computing devices is growing larger and larger. In the recent decade, research has proven that plasmonic devices have exciting characteristics and performance for next generation on chip structures. However, most of these devices contain noble metals and are not CMOS compatible. This work numerically investigates the performance of plasmonic waveguide designs made of TiN, a CMOS compatible material with optical properties similar to gold. Through our work, we demonstrate that TiN nanophotonic devices can be useful for inter-chip connections. A series of simulations using COMSOL Multiphysics were performed to test the performance of these structures. 2D simulations were completed to gain insights into the relationship between the mode size, propagation length trade-off and how additional parameters such as cladding material, a slight mismatch in refractive index of super and substrate, and the thickness of the metal inside the waveguide, affect performance. We found that waveguides using materials of higher refractive will have better mode confinement, albeit with larger losses. If the same material is used, a slight change of refractive index typically in the range of ±0.01, causes the mode to expand to the side of lower index. Additional 3D simulations for waveguide bends, power splitters, and couplers are still in progress. The data of bend loss, power distribution, and mode shapes will be collected upon completion of the 3-D models. With the simulation data, our group will fabricate these waveguides accordingly and attempt further lab experiments to explore how these structures behave.

KEYWORDS

Plasmonics, waveguides, simulation, COMSOL

REFERENCES

Charbonneau, R., Lahoud, N., Mattiussi, G., & Berini, P. Demonstration of integrated optics elements based on long range surface plasmon polaritons. *Optics Express*, *13*, 977-984.Milestone, N. B. (2006).

Kinsey, N., Ferrera, M., Naik, G. V., Babicheva, V. E., Shalaev, V. M., & Boltasseva, A. (2014). Experimental demonstration of titanium nitride plasmonic interconnects.*Optics Express*, *22*(10), 12238-12247.

Babicheva, V. E., Kinsey, N., Naik, G. V., Ferrera, M., Lavrinenko, A. V., Shalaev, V. M., & Boltasseva, A. (2013). Towards CMOS-compatible nanophotonics: Ultra-compact modulators using alternative plasmonic materials. *Optics express*, *21*(22), 27326-27337.