Transformation optics design for optical interconnects

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A major bottleneck in realizing high-performance integrated photonic systems is the inefficient optical coupling between fibers and on-chip waveguides due to their vastly different mode sizes. Conventional edge and grating couplers struggle with fundamental trade-offs in coupling length, bandwidth, and efficiency. Here, we introduce a breakthrough coupler design leveraging transformation optics (T.O.)-based Universal Impedance Matching (UIM) theory for dielectric waveguide systems. This Universal Impedance Matching Coupler (UIMC) theoretically achieves unprecedented coupling efficiencies of over 99% across the entire optical communication band between various dielectric waveguides, all within subwavelength coupling lengths. The complex anisotropic media required by the design are approximated using readily fabricable subwavelength isotropic metamaterials. The efficacy of our approach is further validated by strong experimental agreement with theoretical results in the microwave domain.

References

1. Transformation optics design of an ultrashort, broadband coupler for optical interconnects, Myeongjin Kim, Ku Im and Q-Han Park, to appear