PREFACE

Highly integrated circuits in semiconductor chips are ubiquitous and essential to modern-day life. However, their efficiency and effectiveness are limited by, among other factors, data-transfer rates, signal delays, and interconnect densities. To overcome these limitations, a new approach to data transfer inside semiconductor chips is needed. An attractive new approach is offered by electromagnetic surface waves (ESWs) which propagate guided by the interface of two different materials. Most importantly for data transfer inside semiconductor chips, ESWs are usually highly localized to interfaces. In principle, this localization may allow ESWs to overcome the size mismatch between transistors and optical interconnects inside semiconductor chips, and thereby allow for more efficient transfer of information within integrated circuits. Therefore, a state-of-the-art numerical technique is used in this research to investigate the propagation and scattering of pulse-modulated carrier ESWs in an environment that represents an interconnect such as may be encountered in an integrated circuit.

The most popular ESW is the surface-plasmon-polariton (SPP) wave whose propagation is guided by a metal/dielectric interface. The SPP wave is used as a carrier wave in this thesis to transmit information inside a semiconductor chip. The propagation and scattering of pulse-modulated carrier SPP waves are investigated in the time domain by solving the time-domain Maxwell equations using the finite-difference time-domain method. The materials involved are characterized using well-established models such as the Lorentz and the critical-point models for dielectric materials, and the Drude model for metals. The fidelity of information transmission between the transmitted signal and the received signal is assessed by statistical techniques, which would eventually allow the determination of optimal configurations for information transfer with acceptable fidelity.

Thus, the feasibility of harnessing ESWs for information transfer inside semiconductor chips is established.

The author, from time to time, has reported the present work part-wise at national and international conferences as well as in reputed journals, namely, IEEE Photonic Journal, Journal of Applied Physics, and Scientific Reports.

The author will consider his modest effort a success, if it proves to be useful in the integration of photonic and electronic in the same chip.