Plasmonics: the next chip-scale technology

The development of chip-scale electronics and photonics has led to remarkable data processing and transport capabilities that permeate almost every facet of our lives. Plasmonics is an exciting new device technology that has recently emerged. It exploits the unique optical properties of metallic nanostructures to enable routing and manipulation of light at the nanoscale. A tremendous synergy can be attained by integrating plasmonic, electronic, and conventional dielectric photonic devices on the same chip and taking advantage of the strengths of each technology.

Rashid Zia, Jon A. Schuller, Anu Chandran, and Mark L. Brongersma*

Geballe Laboratory for Advanced Materials, Stanford University, Stanford, CA 94305 USA

**E-mail: brongersma@stanford.edu*

The ever-increasing demand for faster information transport and processing capabilities is undeniable. Our data-hungry society has driven enormous progress in the Si electronics industry and we have witnessed a continuous progression towards smaller, faster, and more efficient electronic devices over the last five decades. The scaling of these devices has also brought about a myriad of challenges. Currently, two of the most daunting problems preventing significant increases in processor speed are thermal and signal delay issues associated with electronic interconnection[1-3]. Optical interconnects, on the other hand, possess an almost unimaginably large data carrying capacity, and may offer interesting new solutions for circumventing these problems[4,5]. Optical alternatives may be particularly attractive for future chips with more distributed architectures in which a multitude of fast electronic computing units (cores) need to be connected by high-speed links. Unfortunately, their implementation is hampered by the large size mismatch between electronic and dielectric photonic components. Dielectric photonic devices are limited in size by the fundamental laws of diffraction to about half a wavelength of light and tend to be at least one or two orders of magnitude larger than their nanoscale electronic counterparts. This obvious size mismatch between electronic and photonic components presents a major challenge for interfacing these technologies. Further progress will require the development of a radically new chip-scale device technology that can facilitate information transport between nanoscale devices at optical frequencies and bridge the gap between the world of nanoscale electronics and microscale photonics.

We discuss a candidate technology that has recently emerged[6,7] and has been termed 'plasmonics'[8]. This device technology exploits the unique optical properties of nanoscale metallic structures to route and manipulate light at the nanoscale. By integrating plasmonic, electronic, and conventional photonic devices on the same chip, it would be possible to take advantage of the strengths of each technology.

ISSN:1369 7021 © Elsevier Ltd 2006