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Plasmonics Bridging the Gap Between Microphotonics and Nanoelectronics

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Summary

The field of optics has a long and colorful history and by now the development of advanced optical structures has enabled tremendous control over the propagation and manipulation of light waves. This control is utilized in many important technological applications, including optical microscopy, solar cells, efficient solid state light sources that could replace conventional light bulbs and plays an important role in biotechnology, medicine, and the modern day telecommunications industry. Until recently, it was thought that the manipulation of light was limited by the fundamental laws of diffraction to relatively large, wavelength scale (about 1 μm) components. Plasmonics is an exploding new field of science and technology in which the flow of light can be molded at the nanoscale using metallic nanostructures. This newly found ability is rapidly impacting every facet of optics and photonics and is enabling a myriad of exciting new technologies.

I will illustrate how most plasmonics applications make use of at least one of two unique properties of metals. One special property of metals is that they can perform simultaneous electronic and optical functions. It is well-established that metals are the materials of choice to carry electronic signals because of their high electrical conductivity. More recently, it was found that their plasmonic properties make them also ideally suited for transport and manipulation of optical signals. Based on this finding, our group set out to realize a variety of new passive and active chipscale components for information transport and sensing. I will discuss the operation of several of these devices.

The second unique property of metals is that they can concentrate light and manipulate it at the nanoscale. It turns out that even a simple spherical metallic particle can effectively concentrate light to the nanoscale. Currently, a number of research groups are further engineering optical antennas to attain gigantic light concentrations by a factor of a million and higher. Such high degrees of field concentration could find application in miniature optical sensors with enhanced light-matter interaction, non-linear optical devices, high efficiency solar cells, and ultra-fast nanoscale detectors and modulators.

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