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Review

Next-generation thermo-plasmonic technologies and plasmonic nanoparticles in optoelectronics

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Abstract

Controlling light interactions with matter on the nanometer scale provides for compelling opportunities for modern technology and stretches our understanding and exploitation of applied physics, electronics, and fabrication science. The smallest size to which light can be confined using standard optical elements such as lenses and mirrors is limited by diffraction. Plasmonic nanostructures have the extraordinary capability to control light beyond the diffraction limit through an unique phenomenon called the localized plasmon resonance. This remarkable capability enables unique prospects for the design, fabrication and characterization of highly integrated photonic signal-processing systems, nanoresolution optical imaging techniques and nanoscale electronic circuits. This paper summarizes the basic principles and the main achievements in the practical utilization of plasmonic effects in nanoparticles. Specifically, the paper aims at highlighting the major contributions of nanoparticles to nanoscale temperature monitoring, modern "drug free" medicine and the application of nanomaterials to a new generation of opto-electronics integrated circuits.

Keywords: Plasmonics; Nanomaterials; Soft matter; Nanomedicine; Optoelectronics

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1. Introduction

Plasmonics is a subfield of nanophotonics, utilizing surface plasmons to control light at the nanoscale by coherent coupling of photons to free electron oscillations at the interface between a conductor and a dielectric. This field of research has emerged as an extremely promising technology with several main fields of application including information technology, solar energy, high-density data storage, life sciences and security. One promising way to localize the optical radiation into a nanometer-sized volume has been realized by using the unique properties of plasmonic metallic nanoparticles which represent an effective bridge between bulk materials and atomic/molecular structures. Nanoparticles can exhibit highly vibrant colors which are absent both from bulk material and individual atoms. The physics behind this phenomenon is based on the collective oscillation of conducting free electrons of the metallic nanoparticles, an