אוניברסיטת בן-גוריון בנגב
Ben-Gurion University of the Negev

מכון אילזה כ"ץ למדע וטכנולוגיה בתחום הננומטרי
Ilse Katz Institute for Nanoscale Science and Technology

Nanotechnology Seminar, Wednesday 4.5.2016, 12:00

IKI Auditorium, Building 51, room 015

Plasmonics: Where it works and where it does not

Jacob B. Khurgin
Johns Hopkins University

Abstract:
Recent years have seen staggering growth of interest in using nanoscale metal/dielectric structures in optical and near IR ranges with the goal of enhancing linear and nonlinear optical properties or even engineering novel optical properties unknown in Nature – usually this burgeoning field is referred to as “Plasmonics and Metamaterials”. After the initial years of excitement the community is slowly beginning to recognize that loss in the metal is an important factor that might impede practical application of plasmonic devices, be it in signal processing, sensing, imaging or more esoteric applications like cloaking. Yet there is still an optimism that the loss can be either cleverly “designed away”, compensated by gain, or a new lossless materials can be found. In this talk we examine these concepts one by one and find that they all have limitations. First we show that when it comes to enhancing the device performance (solar cells, sensors etc.) only the most inefficient devices can be improved by plasmonics while the performance of any decent device will only degrade. Then we demonstrate that in truly sub-wavelength metal structures the metal loss is inherent and cannot be engineered away by clever changes in shape. We then consider the idea of compensating loss using semiconductor gain medium and demonstrate that required gain can never be achieved due to increase in recombination rates caused by Purcell effect. After that we consider the physics of losses in metals at optical frequencies and show that the nature of these losses is quite different from the losses in RF domain. W econclude that plasmonics works very well wherever high absolute efficiency is not required such as in sensing or where all one wants is to achieve heating or thermal emission.