CALIFORNIA STATE SCIENCE FAIR
2007 PROJECT SUMMARY

Name(s)

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Project Number

S1619

Project Title

Dynamics of Surface Plasmon Propagation on Nanoparticle Arrays

Abstract

Objectives/Goals

The paper characterizes the behavior of localized surface plasmon polariton (LSPP) propagation on two-dimensional metal nanoparticle arrays. As excitations of surface electrons on metal nanoparticles, surface plasmons can be propagated by Coulomb interactions between nanoparticles. Plasmonics has been proposed as a superior approach for data transmission and processing by synthesizing the advantages of modern optics and electronics. The chief objective of this study is to describe and define the basic dynamics of LSPP.

Methods/Materials

Previous theoretical studies for LSPP dynamics have been limited by the expensive computational cost of solving the full set of Maxwell's equations. In this study, a novel quantum approach based on quantum scattering theory and the exciton model for excitations is used. We develop and run algorithms in Fortran, Matlab and Mathematica to computationally model and analyze the LSPP propagation. Focusing on the "optical" behavior of plasmon propagation, the study simulates plasmon propagation on arrays of nanoparticles of two disparate regions of densities.

Results

Results describe an analogue to Snell's Law for classical optics for plasmonics, relating the ratio of nanoparticle density with the angles of reflection and refraction off the interface between the two regions of nanoparticles. A second order polynomial relation is also found to describe the probability of transmittance through the interface between two different nanoparticle arrays with the magnitude of the initial momentums of the LSPP.

Conclusions/Discussion

The study add specific understanding behind the dynamics of surface plasmon propagation. The results show that plasmonics generally follows dynamics defined by classical optics in the case of reflection and refraction angles. However, results describe exotic behavior for transmissions of plasmons through the interface between media. The study may contribute to the development of new, exotic materials and devices taking advantage of the unique properties of plasmonics.

Summary Statement

Using a quantum approach, the project describes the analagous "optical" dynamics of surface plasmon propagation on metal nanoparticle arrays.

Help Received

Learned about subject at UCLA Chemistry Department under supervision of Mr. Kenneth Lopata