CALIFORNIA STATE SCIENCE FAIR
2005 PROJECT SUMMARY

Name(s)
Linnea L. Motts

Project Number
S0713

Project Title
The Influence of Periodic Structure of Colloidal Crystals on Indium Tin Oxide using Optical Gradient Forces

Abstract

Objectives/Goals
The experiment investigated whether plasmon oscillation of Ag plasmons with an ideal resonance frequency of 410nm would diverge more of the normally nondiverged Heaviside energy flow, free flowing EM energy from a dipole that usually does not interact with anything to any significance and is thus wasted. By oscillating the Ag plasmons, more EM energy is diverged onto the particles which are attached to an ITO substrate used as an electrode.

Methods/Materials
Using a UV light source with a gradient, colloidal silver plasmons were deposited in an ordered array on ITO film, which was later used as an electrode in a colloidal battery with a silver colloid electrolyte. The colloidal battery consisted of a magnetic field, electric field, and a UV light source all perpendicular to each other. Three UV light sources were tested - UV LED, UV lamp, and a 409 nm laser each with different wavelengths. Once the Ag colloids are deposited onto the ITO film, they are refered to as Ag plasmons.

Results
The data supported the hypothesis in that the battery configuration Ag colloids on ITO film deposited in an ordered array resulted in the greatest power output of the electrodes tested. The results were extremely promising in that with all three light sources, there was a percent increase in power output of about four hundred percent. To increase power output and efficiency, the colloids or surface plasmons must be arranged in a very ordered array to minimize random movement and consequent power loss. Consequently, the experiment supports the ability to diverge more Heaviside energy onto Ag plasmons, thus creating a "super battery" that has a greater power output than would a battery without the oscillation of the Ag plasmons.

Conclusions/Discussion
From the experiment, it is safely concluded that the fabrication of the electrodes is very significant to the power output of the colloidal battery. With more sophisticated technology available, the experiment would undoubtedly produce much more impressive results. The experiment also showed that the colloidal battery has some storage capabilities; hence, the colloidal battery could also be considered a wet cell storage device. The plasmon oscillation could also be used in conjunction with a PV cell. Instead of merely converting light energy into electrical energy, a PV cell with plasmon oscillation could potentially store charge generated from light energy.

Summary Statement
The experiment investigated whether more energy can be diverged onto Ag surface plasmons on electrodes in a battery through plasmon resonance frequency.

Help Received
Father provided materials used in experiment.