1-1-2015

Engagement of Undergraduate Student for Frontier Research: Trapping Light with Plasmonic Nanostructures for Sensors

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Summary

This project provides a transformative opportunity for an undergraduate student to gain hands-on research experience in the area of nanophotonics in Prof. Guo's lab at UAH (http://guolab.uah.edu). In this program, the undergraduate student will conduct FDTD numerical simulations on new photonic nanostructures for trapping photons. Light trapping in nanostructures can enhance light-matter interaction and lead to high sensitive chemical sensors for contaminant detections, and better medical instruments for treatment of illnesses. The undergraduate student will be directly supervised by Dr. Guo and work closely with two Ph.D. graduate students for carrying out device fabrication and characterization experiments.

Student Duties

The undergraduate student will work in Prof. Guo's lab under Prof. Guo's direct supervision for 36 hours per week as an undergraduate research assistant. The student will be trained to use a FDTD numerical simulation software to conduct numerical simulations on plasmonic nanostructures. The student will also learn how to plot the simulations results by using Matlab. An example of the light trapping device structure is shown in the Figure. 1. The structure is called gap mode resonance structure. Photons can be trapped in the gaps between the metal squares and the bottom thick metal film. Figure 2 shows the simulated electromagnetic field inside the gap at several resonance modes. It is clearly seen that the optical energies (photons) are trapped inside the nano-gap structures at the resonance wavelength. Here is a list of subjects that the undergraduate student will learn: (a) Matlab programing; (b) Lumerical FDTD simulation; (c) script programing with Lumerical FDTD; (e) plotting calculation results Matlab; (f) nano-device fabrication; (g) device testing with visible and near IR light source and optical spectrometers. Student's tasks will be: (a) find the optimized structure that provides most efficient light trapping; (b) making such nanostructures with helps from graduate students; (c) testing the devices with the help of a Ph.D. student, Hong Guo; (e) write a report and give a poster presentation. Backgrounds of Electromagnetics and Optoelectronics classes are required for the student. The student should be highly motivated for working in Prof. Guo's lab and can collaborate well with other students in the group. The student should be an undergraduate student majored in the Electrical Engineering.

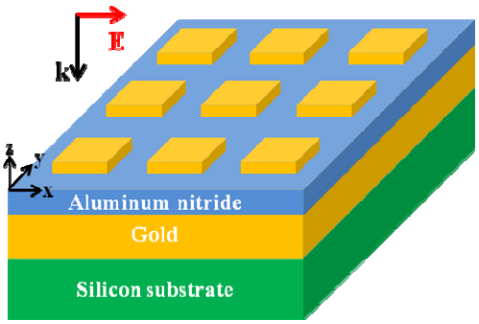

Figure 1. Schematic of the perfect light trapping nanostructure.

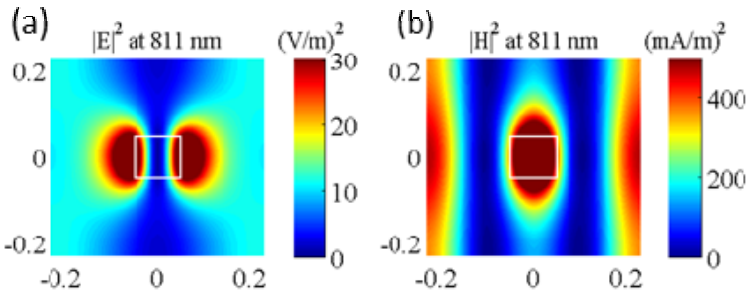

Figure 2. Simulated electric filed (a) and magnetic field (b) inside the gap at the resonance.

Mentor Supervision and Interaction

The student will work 36 hours a week for 12 weeks in the Professor Guo's Nanophotonics and Plasmonics Lab in the Optics Building. Dr. Guo will meet with the student twice a week. A Ph.D. graduate student Wonkyu Kim will meet with him/her every day for supervising his numerical simulation work. Another Ph.D. student, Hong Guo will help him/her in doing fabrication and testing experiments. Administrative assistance will be provided by Mrs. Jackie Carlson in the Center of Applied Optics. The student will directly report to Prof. Guo. The student will participate Dr. Guo's group meeting and present his/her results. A report will be written by the student. And a paper will be derived from the project. The research experience gained from this program will benefit significantly for the student's future career as an engineer or research scientist.

Dr. Guo is a Professor of Electrical Engineering at University of Alabama in Huntsville. He received his Ph.D. degree in Electrical Engineering from the University of Illinois at Urbana-Champaign in 1998. Before joining UAH, he worked as a Member of Technical Staff at Sandia National Laboratory and also worked as a Research Scientist at Rockwell International Science Center. Prof. Guo's current research is nanophotonics and plasmonics for sensing and energy harvesting. His research has been supported by NSF, NASA, and USDA. Dr. Guo received an ASEE-Air Force Office of Scientific Research Summer Faculty Fellowship in 2010 and an ASEE-Naval Research Office Summer Faculty Fellowship in 2011. Prof. Guo also received the Alan Berman Research Publication Award at NRL in 2013. Dr. Guo is a Senior Member of the Optical Society of America and a Senior Member of The International Society for Optics and Photonics. He has authored and co-authored over 40 journal papers and given over 80 conference presentations on optics, photonics, and plasmonics. He has three US patents. Dr. Guo currently supervises nine graduate students working in his research group at UAH. Dr. Guo is also affiliated with the Nano and Micro Devices Center at UAH.