CALIFORNIA STATE SCIENCE FAIR
2013 PROJECT SUMMARY

Name(s)

Anjini Karthik

Project Number

S0614

Project Title

Novel Environmentally Benign Synthesis of Metal Nanoparticles for Surface Enhanced Raman Spectroscopy

Abstract

Objectives/Goals

Goal: To produce metal nanoparticles using plant material and test viability of the nanoparticles for Surface Enhanced Raman Spectroscopy (SERS). Challenge: Nanotechnology is a hot field of intensive research; one important application is SERS. SERS is an extensively used industrial method in applications like detection of pathogens, security threats, and medical diagnoses, as SERS gives a fingerprint of the molecule studied. SERS uses Au and Ag NPs as a substrate to enhance the Raman spectrum of a molecule. However, the conventional methods of producing these NPs use harsh chemicals that are toxic to the environment and body. It is critical that these NPs be produced in a safe green way. Proposed Solution: Plants contain naturally occurring, non-toxic phytochemicals. It was hypothesized that NPs produced in a green way using plant material could be harnessed for SERS; secondary hypothesis was that AgNPs would show greater Raman signal enhancement than AuNPs.

Methods/Materials

Water was the solvent and plant material was the reducing/capping agent for NP production. Cinnamon was used for AuNPs and curry leaves for AgNPs. Both AuNPs and AgNPs were also conventionally produced with sodium citrate. After production, NP solutions were titrated with Rhodamine 6G, and SERS spectra were recorded. Negative control was the Raman spectrum of R6G (no enhancement from NPs); positive control was the ideal SERS spectrum of R6G (laboratory standard).

Results

AuNPs and AgNPs were successfully produced with plant material. AuNPs made a viable SERS substrate, but AgNPs did not until aggregated with NaCl. Data is qualitative; enhancement of Raman signal is shown by matching peaks to positive control. Molecular fingerprint of R6G was clearly identified.

Conclusions/Discussion

Metal NPs produced in a green way could be successfully harnessed for SERS; AuNPs gave a better Raman signal enhancement than AgNPs. The wavelength of the laser of the Raman spectrometer was compatible with the peak wavelength for AuNPs, but not compatible for AgNPs - therefore, electronic excitation was not induced in the AgNPs until aggregated. Hypotheses were partially supported. SERS has several applications in the real world, including detection of food and water-borne pathogens, terrorism threats, gemology/mineralogy, and non-invasive medical diagnoses. This project is a new approach for SERS with viable, environmentally-friendly metal nanoparticles.

Summary Statement

The project investigated a novel green method to produce metal nanoparticles that could be successfully utilized for Surface Enhanced Raman Spectroscopy.

Help Received

I acknowledge my family and teacher for their support and Dr. Terrill from San Jose State University for guidance and for granting me access to lab equipment.