CALIFORNIA STATE SCIENCE FAIR
2008 PROJECT SUMMARY

Name(s)
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Project Number
S0511

Project Title
Novel Approach for the Self-Assembly of Gold Nanorods

Abstract

Objectives/Goals
I'd like to demonstrate high-yield synthesis of gold nanorods and their self-assembly into ordered structures. The assembly of gold nanorods into 2-D structures was carried out using a pH-sensitive polymer, polyacrylic acid. Because gold nanorods are covered with a cationic surfactant in solution, the pH-dependent assembly of the nanorods is directed by electrostatic interactions between the positively charged nanorods and the negatively charged, deprotonated polyacrylic acid. Because the chemically-directed, spontaneous self-assembly of nanoparticles by manipulating environmental factors such as pH are rare, such modes of assembly can be used as a precursor for synthesizing future nanodevices.

Methods/Materials
Gold nanorods were created via the seed-mediated approach. After their synthesis, nanorod self-assembly was carried out using a pH-sensitive polymer, polyacrylic acid. After the addition of the acid to the gold nanorod solution at pH of 7, the solution was observed using light scattering experiments, zeta-potential measurements, and absorption spectroscopy to see if any gold nanorods had self-assembled into ordered structures in solution, in addition to TEM.

Results
Gold nanorods assembled into 2D ordered structures with polyacrylic acid at pH of 7 but not at a pH of 3 to yield 2D ordered structures. Zeta potential measurements indicated that negatively-charged polyacrylic acid is adsorbed on the surface of gold nanorods, and light scattering experiments indicated that nanorods formed aggregates of 4-5 gold nanoparticles in solution. The absorption peak also shifted 20 nm left, indicating side-to-side assemblies in solution.

Conclusions/Discussion
The self-assembly of gold nanorods in solution prompted by the presence of polyacrylic acid was achieved. While most assembly was induced by solvent evaporation due to particle-particle interactions, light scattering experiments and absorption spectroscopy showed that some self-assembly also occurs in solution. These aggregates are estimated to contain 4-5 nanorods in solution, and upon evaporation, form assemblies containing hundreds of nanorods as observed by TEM. The mechanism for self-assembly is believed to be electrostatic attractions, and as a result, nanorods were aggregated in solution. It is expected that the present studies on the controllable connection of nanoscale building blocks into desired shape might find application in future nanodevices.

Summary Statement
I discovered how to self-assemble gold nanorods using electrostatic interactions between nanoparticles.

Help Received
Prof. Wendy Chiu helped me at UC Davis chemical engineering department