

Project # 6: Applications of Nanotechnology in Health and Beauty Products

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Abstract

Research in the area of nanotechnology continues to be of growing interest within many science and engineering disciplines. One area of focus in nanotechnology is the synthesis and characterization of nanoparticles, particles that range in size from 1 nanometer up to 1 micrometer. Research on nanoparticles is not limited to spherical particles, however, as other structures such as nanorods, nanodiscs and carbon nanotubes are also commonly investigated. The focus of the proposed project is to demonstrate the synthesis and characterization of nanoparticles and to explore the use of nanotechnology in commercial products. The project is divided into three areas: synthesis of nanoparticles in aqueous solutions, instrumentation used to analyze nanoparticles and a case study of the use of nanotechnology in consumer products.

The first part of the project provides an overview of how nanoparticles are fabricated. Gold particles will be created through a 'green synthesis' technique, which uses ingredients that are safer for the environment compared to other synthesis techniques. The goals of the 'green' gold particle synthesis are to demonstrate the fundamental chemistry used in nanoparticle synthesis, understand how synthesis conditions influence the structure of nanoparticles and to discuss some of the environmental and health concerns related to nanotechnology.

The second part of the project will introduce nanoparticle morphology and the instrumentation used in characterizing nanoparticles. The basics of microscopy will be presented through the use of a light microscope to study the morphology of various samples at the micrometer size scale. Hair fibers will be collected and analyzed to determine the size and texture of the fibers. The hair samples will also be used in part three of the project, where the hair will be treated with various hair care products. The gold particles synthesized in the first part of the project will also be imaged using the light microscope. While the smallest particles will not be visible with the light microscope, some of the larger particles and the particle agglomerates will be visible. Following the hands-on experience with the light microscopes, electron microscopy will be presented. The presentation will explain how electron microscopes work, the type of information obtained from the instruments and how samples for electron microscopy are prepared.

The third part of the project will use electron microscopy to study the gold particles and to observe how several hair care products interact with human hair. The gold particles will be prepared for use in the scanning (SEM) and transmission (TEM) electron microscopes. Images of the particles will be collected and the particle size and morphology analyzed. Two different types of hair color products will be applied to the hair samples and the effect on the structure of the hair will be determined using the SEM. For both of the colored hair samples, the surface of the hair fibers will be examined to see if anything is deposited on the surface of the hair during treatment. Images will be collected of any features that are found on the

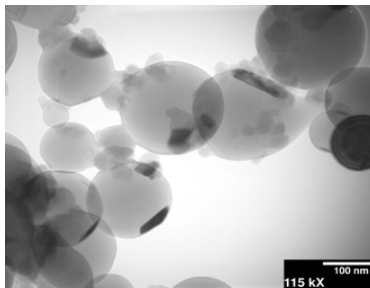
fibers and the elemental composition of the features will be determined using the SEM. The final group of samples will be hair fibers treated with different hair styling products. The SEM will be used to capture images showing the interaction of the products with the hair fibers. The images will be analyzed to determine what kind of networks form between the fibers and the extent to which the fibers are coated.

Possible Ideas for Classroom Implementation

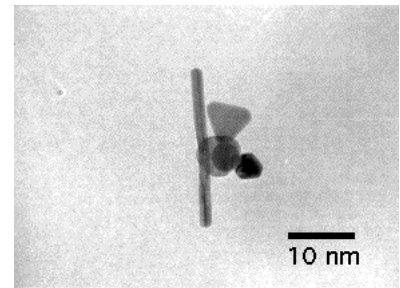
The proposed project is intended to provide an introduction to nanotechnology, focusing on nanoparticle synthesis, characterization and applications. Each section of the project utilizes fundamental math and science concepts, which can be expanded upon further for specific courses. The individual experiments are designed for small groups of students to encourage collaboration and a shared learning experience. The use of electron microscopy is intended to directly expose students to nanotechnology and provide an accurate sense of the 'nano' size scale. Each of the nanotechnology applications explored are expected to encourage students to make a connection between 'nano-concepts' and practical objects that they encounter on a daily basis, whether the objects are synthetic or natural.



Transmission Electron Microscope (TEM)



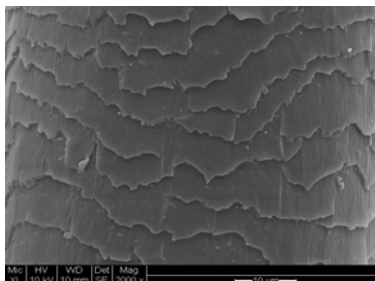
TEM Image of Al-Cu Nanoparticles



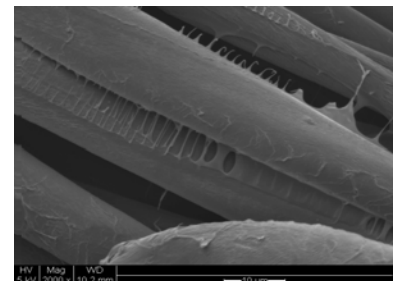
TEM Image of Silver Nanoparticles



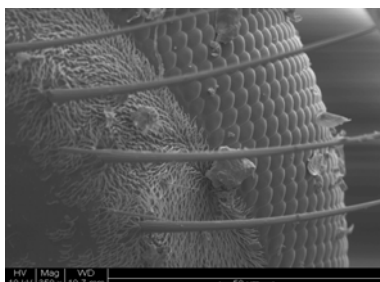
Environmental Scanning Electron Microscope (ESEM)



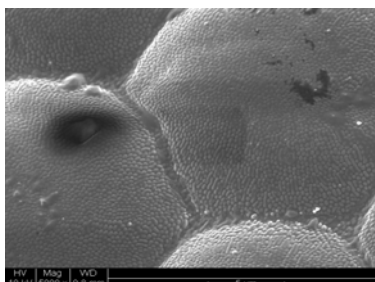
SEM Image of the Surface of a Hair Fiber



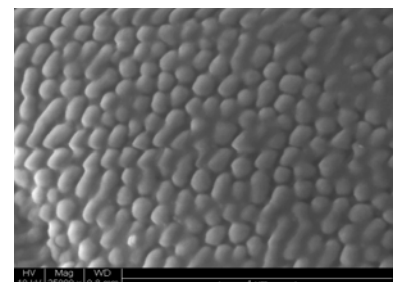
SEM Image of Surface Treated Hair Fibers



SEM image of the Compound Eye of a House Fly



Higher Magnification View of the Compound Eye



Surface of the Eye Showing Nanoscale Features