CALIFORNIA STATE SCIENCE FAIR
2017 PROJECT SUMMARY

Name(s)

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Project Number

S0626

Project Title

Synthesis of Paramagnetic Iron Oxide Nanorods

Abstract

Objectives/Goals

Currently, nanomaterials with high magnetophoretic velocity and magnetic susceptibility are needed for various applications such as drug delivery systems and bioseparations, but many paramagnetic nanomaterials cannot be easily controlled by an external magnetic field. Scientists are trying to synthesize anisotropic material that has superior magnetic properties due to the unique morphology. The goal of this project was to synthesize paramagnetic iron oxide nanorods with properties suitable for biomedical applications that can be easily controlled by an external magnetic field.

Methods/Materials

Iron oxide nanorods were synthesized using a modified sol gel method. Iron (III) chloride was hydrolyzed, and sodium sulfate was used to control the morphology. The nanorods were coated with polyacrylic acid so that they could be dispersed in water. A silica coating was done to reduce the aggregation between the nanorods. The sample was subjected to a forming gas reduction, and this sample was used to prepare a polymer thin film using polyethylene glycol diacrylate (PEGDA) as the polymer. The magnetic properties of the nanorods as a result of their shape anisotropy were demonstrated by exposing the thin film to a NdFeB magnet.

Results

TEM images taken at each step showed that the nanorods formed without much aggregation, and the PAA and silica coatings improved the particles# stability and dispersibility. Under the optical microscope, the nanorods were paramagnetic when exposed to an external magnetic field. The diameter of the silica coating is ~40 nm, and the length on the long axis of the nanorod is ~400 nm. The direction of the magnetic field could be easily controlled by an external magnetic field and fixed in the polymer with a thickness of 170µm by UV irradiation. When this polymer was exposed to an external magnetic field, the nanorods attempted to align the direction of their magnetic field with that of the magnet, resulting in bending of the polymer.

Conclusions/Discussion

Due to shape anisotropy, the nanorods have a high magnetophoretic velocity, as demonstrated by the polymer#s response to an external magnetic field. Additionally, the dispersibility in water, low toxicity of iron oxide, and relatively low aggregation makes the nanorods suitable for various biomedical applications such as bioseparations, targeted drug delivery systems, and immunoassays where a strong magnetic attraction is advantageous.

Summary Statement

A method to synthesize paramagnetic iron oxide nanorods was investigated with the purpose of easily controlling the nanorods by an external magnetic field due to the effects of the shape anisotropy.

Help Received

I used the lab equipment in the lab of Dr. Yin at the University of California Riverside under the supervision of Dr. Yadong Yin and Xiaojing Wang.