

CHEM 8212 Advanced Analytical Chemistry
Midterm Exam
March 24, 2020

Answer the following questions about each topic:

1. (30 pts) **Metal nanoparticles:**

- a) (10 pts) Explain localized surface plasmon resonance (LSPR).
- b) (10 pts) Why do gold nanorods have two absorption peaks?
- c) (10 pts) Give one method to make gold nanorods and outline the major steps.

a) LSPR is the collective oscillation of free electrons (conduction band electrons) of a metal that is in resonance with the incident light and confined to a finite volume such as a nanoparticle.

b) Gold nanorods have two absorption peaks because the free electrons can collectively oscillate in two directions, one along with the long axis of the rod resulting in longitudinal absorption peak, and the other along with the short axis resulting in transverse absorption peak.

c) The most common method to make gold nanorods is Seed-Mediated Growth method. The major steps are:
Step 1: Preparation of the seed. In this step, ice-cold NaBH_4 reduces HAuCl_4 solution to form small gold nanoparticles of 2-5 nm.

Step 2: Growth of gold nanorods. In a growth solution containing HAuCl_4 , AgNO_3 , and CTAB, ascorbic acid is added to reduce the gold salt to Au^0 precursors. Then the seed solution is introduced to initiate the anisotropic growth of the gold seed into rod shape.

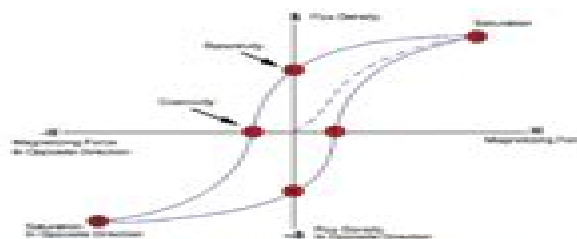
2. (30 points) **Magnetic nanoparticles:**

- a) (20 pts) Schematically compare the differences of superparamagnetic and ferromagnetic properties.
- b) (10 pts) Design a nanostructure that can be used for both magnetic resonance imaging and dark field light scattering imaging.

a) **Superparamagnetic**



Ferromagnetic



b) Iron oxide-gold core-shell nanoparticles. Due to the magnetic properties of the iron oxide core, the nanoparticles can be used for magnetic resonance imaging. Due to the optical properties of the gold shell, the nanoparticles can be used for dark field light scattering imaging.

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