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3.034 FALL 2005
ORGANIC AND BIOMATERIALS CHEMISTRY

LABORATORY EXPERIMENT 1

Nanoreactors and Bacteria

PreLab Questions:

1. Why is the reaction in this lab within the polyelectrolyte multilayer termed a “nanoreactor” process?
2. Describe the role of silver acetate and BDMA in this reaction.

I. Introduction

It has been known since ancient times that silver provides an antibacterial surface. This is why, for example, silverware actually used to be made from Ag and religious ceremonies in which many people drink wine from the same chalice still use silver vessels. A modern example of this antibacterial property of silver is demonstrated by a fabric marketed for sports clothing, called X-Static, which contains 15 vol% silver fibers (Fig. 1).

Figure 1. Polartec® PowerDry® feature XStatic®, advertised to “eliminate 99% of bacteria to give garments permanent natural odor protection.”
X-Static website: <http://www.cloverbrook.com/xstaticpage.htm>.

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In this laboratory experiment, you will synthesize Ag nanoparticles within an ultra-thin polymer film known as a polymer multilayer (PEM) through a reduction reaction. Because the reaction volume is determined by the molecular organization within the multilayers, the thin film itself acts as a nanoreactor to define the final size of the Ag particles. This is because the metal ions in a silver-containing solution (Ag^+) attach to the polymer by exchanging with hydrogen in, for example, carboxylic groups of the polymer, and then reduce to metal particles (Ag^0) by exchanging with hydrogens in, for example, the amine groups of a second chemical such as a diamine. Thus, the polymer multilayer is a nanoreactor that is capable of creating uniformly dispersed, nanometer sized particles of Ag metal (~2 – 4 nm diameter). You will characterize the Ag content of the samples through UV-Vis spectroscopic analysis of energy absorption, and correlate this Ag content with the ability of these Ag-loaded multilayers to kill bacteria that are seeded and cultured on the surface.

II. Objectives

The goals of this laboratory experiment are to:

- Synthesize silver nanoparticles through a reduction reaction within the polyelectrolyte multilayers (PEMs)
- Estimate the extent of Ag-loading through energy absorbance spectroscopy and comparison to literature data
- Seed bacteria onto PEMs and quantify the number of bacterial colonies produced as a function of Ag-loading.