

ANTIMICROBIAL COATING SYSTEMS BASED ON SILVER NANORODS.

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INTRODUCTION

A significant body of work has examined the emulsion polymerization in the presence of inorganic particles. This process has been utilized to encapsulate SiO₂ and TiO₂ in polybutyl acrylate[1], SiO₂ in polystyrene[2, 3], magnetite in PMMA, PolyHEMA and in polyacrylamide to create magnetic polymer particles[4, 5], alumina in PMMA to improve the curing and mechanical properties of bone cement[6], and CaCO₃ in PS[7], among many others. In almost every case, the literature reports the encapsulation of spherically, or roughly spherically, shaped particles. Two exceptions are the report of Zeng et. al. in 2005 on the preparation of core-shell alumina polystyrene composites that consisted of alumina needles surrounded by a PS shell[8] and the work conducted by Ham on the preparation of SWNTs covered with PS particles through the emulsion polymerization process[9, 10]. Outside of these two efforts little work has been performed on the emulsion polymerization in the presence of rod shaped particles. This work will seek to develop methods for encapsulation of rod shaped silver particles and thus increase the body of knowledge relating to emulsion polymerization in the presence of rigid rods.

Nanosize metal particles have attracted significant attention because of their unusual size-dependent optical and electronic properties. These particles show potential applications in various fields such as environmental remediation, biomedical, catalysis, optics and electronics [11]. For example, AgNP are currently used in diagnostic biomedical optical imaging [12]. In addition, the surface plasmon resonance and large effective scattering cross-section of individual silver nanoparticles make them ideal candidates for molecular labeling, where phenomenon such as surface enhanced Raman scattering can be exploited [13]. Since the anisotropic nanoparticles have greater surface area than spherical nanoparticles, their metal enhanced fluorescence is higher than that of spherical nanoparticles [14], the high surface-to-volume ratios of the NPs lead to dramatic changes in their properties.

Recently, a microwave heating method has been developed and used for the synthesis of nanomaterials at a significantly higher speed than conventional thermally heated reactions [15-17]. The microwave irradiation generates very fast nucleation sites in the solution, which significantly enhance the reaction rates. Tusji and co-workers [17] have reviewed the preparation of Ag nanostructures in PVP using microwave. They determined that the colloidal stability (for colloidal solutions), particle size, and the properties of nanoparticles depend strongly on the specific method of preparation and the experimental conditions applied. In addition, to spherical particles, one-dimensional (1-D) nanostructures (rods, wires, and tubes) of silver have received considerable attention from a broad range of researchers because of their wide application to catalysts, scanning probes, and various kinds of electronic and photonic nanodevices [18, 19]. Tusji and co-

workers have recently succeeded in fast preparation of such anisotropic Ag nanostructures as nanorods, nanowires, nanosheets, nanoplates, and nanocubes by using a microwave heating method [16, 17, 20].

One of the potentially key experimental conditions that to date has remained unaddressed is the type of power control used on the microwave system. Typical commercial microwaves utilize pulsed power control in which the magnetron is pulsed on and off at full power. By varying the ratio of on vs. off time the total power delivered to the chamber is controlled. However, this method can cause rapid initial heating at the surface of the target followed by a cooling phase and heat flow into the target bulk. An alternate method is to control the power delivered to the magnetron but maintain the power level continuously. The lower power delivered to the target combined with the continuous power deliver may be expected to alter the nucleation and thus overall reaction rates. Another factor is the surface to volume ratio of the target as the energy density would be expected to decrease as you move into the sample from the surface. In the present research the effects of microwave power control and the vessel shape on the rapid, aerobic preparation of uniform Ag nanowires by microwave irradiation are explored. Modifications to the polyol synthesis method developed by Xia et al. [21, 22] and by Zaleski et.al [15] has been evaluated for the potential to reduce reaction time and increase the yield of rods and wires.

RESULTS TO DATE:

The following lists the main accomplishments generated during the development of the proposed work:

1) Evaluation of physically mixed composite coating systems based on latex systems and silica sol.

Model latex systems with and without the cross linking agent 3-(trimethoxysilyl) propyl methacrylate (MSMA) were prepared. Stability of physical blends of these latexes and silica sol were determined. MMFT was determined and found to be a strong function of silica loading.

2) Preparation of Silver Nanorods.

A microwave assisted synthesis method was evaluated for the production of silver nanorods. Testing to determine the effect of microwave power and time and the reaction vessel shape on the rod formation rate was conducted. Initial results indicate the shape of the reaction vessel strongly influences the rate of rod formation.

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