

CHAPTER I

INTRODUCTION

During the past two decades, there has been a lot of work from many research groups examining the formation of thin polymer film on inorganic particles. These materials represent a new class of polymeric materials which combine the properties of the inorganic particles (in terms of mechanical strength, modulus, thermal stability) with the processability and flexibility of the organic polymer matrix. In order to make the surfaces of inorganic particles such as silica, alumina, and titanium dioxide more compatible with the composite hosts in which they are mixed, siloxane, titanate, and zirconate coupling agents are used extensively in industry for this purpose. However, they can be expensive, thus significantly increasing the cost of a product. (O'Haver *et al.*, 1994)

Admicellar polymerization, a simple surface modification method, is used in this work to synthesize polymer films. Admicellar polymerization, derived from polymerization in "adsorbed micelles", takes place inside adsorbed surfactant aggregates on various substrates, almost always inorganic particles with hydrophilic surfaces in order to improve interfacial adhesion between polymer matrix and filler (Wei *et al.*, 2003). This phenomenon has been widely used on many types of inorganic substrates and with a variety of polymerizing monomers (tetrafluorethylene, styrene, pyrrole, isoprene and butadiene) inside cationic, anionic, or non-ionic surfactant admicelles. The process can be photochemically and thermally activated with either initiators that are soluble or virtually insoluble.

The advantage of admicellar polymerization relative to other surface modification methods are the following: (1) small amounts of usually common chemicals are needed; (2) there are no organic solvents involved, which makes the process economical and almost free of waste; and (3) the process is robust as can be applied on a variety of substrates and geometries with very good adhesion.

Admicellar polymerization has opened up an entirely new area of study in which its fundamentals and possible applications have been and continue to be investigated. Admicellar polymerization has proven applications for interfacial adhesion improvement in polymer-matrix composites (Waddel et al., 1995), modification of surface wetting behavior (Barraza *et al.*, 2001), coefficient of friction (Lai *et al.*, 1995), conductivity enhancement in conductive composites (Yuan *et al.*, 2001) and several other potentially important commercial applications.

Although previous studies showed that the admicellar polymerization process is able to improve surface properties, some of these studies have not provided insights into any changes that may occur in the characteristics and morphology of polymer films because of changes in the process, specifically changes in the concentrations of the surfactants and monomer. Thus, it is important to study these due to their potential impact on the various current and potential application of the process (See and O'Haver, 2003).

There are previous studies on the characteristics of polystyrene films formed via admicellar polymerization on various types of silica substrates, but most of these systems use the ionic surfactants which are sensitive to hard water and show higher aquatic toxicity. Hence an alternative route is focused on using non-ionic surfactants which are normally compatible with all other types of surfactants, not sensitive to hard water, and their physicochemical properties are not markedly affected by electrolytes.

This research will investigate the aspects of polystyrene thin film formed during the admicellar polymerization process under various polymerization conditions. It will examine the effect of the amount of monomer and surfactant on the formed polymer as well as on the distribution and structure of the formed film. The system will be carried out on a non-porous silica substrate (Aeroxil OX[®]50) using a non-ionic surfactant (Triton X-100) so that the polymer is easily extracted. The modified silica and extracted silica are examined by FTIR, TGA, and AFM. The extracted polystyrene is characterized by FTIR, TGA, and GPC.