



CHAPTER I

INTRODUCTION

Polyoxymethylene (POM), also known as polyacetal, is a very versatile engineering thermoplastic, offering excellent desirable properties that bridge the gap between metals and ordinary plastics. Some of these desirable properties include high tensile strength, impact resistance, stiffness and a wide end-use temperature range. It is also one of the promising materials to replace other engineering plastics such as polycarbonate and nylon due to its low cost and easy polymerizing. Generally, POM is fabricated by injection molding to form molded-shape products as well as by melt spinning to produce a POM fiber. However, low impact toughness, sensitivity to notch, and low heat-resistance limit the applications.

Development of POM by various strategies, for example, copolymerizing with oxyethylene chain (Pace-Rodriguez RA *et. al* 1990, Matzusaki K *et. al* 1997) blending with elastomers (Chiang *et. al* 1989, 1993) are proposed in the past. Traditional fillers for polyoxymethylene are calcium carbonate, glass fiber, talc, etc. The hybridization with inorganic fillers, especially organoclay, to form nanocomposites is another approach to improve the properties of POM from the nano-scale structure. The incorporation of a few percentages of layered silicate fillers into the polymer matrix brings significant increases in stiffness, strength, and heat resistance (Kojima *et. al* 1994), together with decreases in flammability (Usuki *et. al* 1993, Zhang *et. al* 2003) gas permeability (Usuki *et. al* 1993), and moisture absorption (Osman *et. al* 2004), as compared to micro- and macro-scale polymer composites. Silicate layers or clays such as montmorillonite, hectorite, and bentonite have been comprehensively considered in more detail, for example, aspect ratio, ionic strength, orientation, and intercalation of the polymer matrix (Kojima *et. al* 1994, Alexandre *et. al* 2000, S.S. Ray and Okamoto 2003).

Although the success of POM/organoclay nanocomposites might bring about an improvement in physical and mechanical properties of POM, such as impact toughness, heat distortion resistance, gas barrier property, only a few reports are proposed. This might be due to the difficulty in modifying the POM structure to achieve the intercalation into the clay galleries. W. XU *et. al* (2001) studied the

nonisothermal crystallization kinetics of POM/montmorillonite (MMT) in which the crystallization rate was found to be faster than that of the neat POM at a given cooling rate. Pielichowski K. *et. al* (2006) reported the mixed tactoid-exfoliated structure and the mechanical properties of POM/MMT nanocomposites.

Despite the fact that the preparation of POM nanocomposites has been reported, the study on the factors favoring to the nanocomposite formation at molecular level, including the miscibility between polymer chain and surfactant, the insertion intercalation of surfactant, processing conditions, and the type of clay, has not yet been clarified. The present work focuses on the clarification of different surfactant used for clay modification affected to POM/organoclay nanocomposite formation, including its properties.

Fine fibrous POM is also another challenge in the present work. The applications on membrane or filter for hydrocarbon fuel and hydraulic fluid can be expected. Melt spun POM is an alternative choice for exploring new applications; however, the difficulty is about the degradation of POM melt under elevated temperature (Samon *et. al* 2001). A copolymer of POM with an oxyethylene unit helps the thermal stability of POM due to the less unzipping to retard the degradation (Duan *et. al* 2006).

In order to achieve fine fiber, the present work considers electrospinning technique as it is known as a way to produce fine fiber with diameters ranging from nano- to micro-scale (Reneker and Chun 1996). The many electrospun polymers. e.g. nylon 6 (Berghoef *et. al* 1999), PLLA (Bognitzki *et. al* 2001), PEO (Doshi and Reneker 1995), and PE (Givens *et. al* 2007), were developed either from polymer solution or from polymer melt. The fine fibers provide high surface area to volume ratios which is useful for specific applications, such as active reagent carriers in controlled release system (Jun Zeng *et. al* 2005), scaffolds in tissue engineering (Yang *et. al* 2005), mat in wound dressing (Chen *et. al* 2008), military wears with chemical and biological resistant protection (Gibson 1999), nanofibrous membrane or filter (Katarzyna *et. al* 2006). as well as electronic sensors (Wang *et. al* 2002, 2004). The study also covers the fiber structure at the molecular level based on the X-ray structural analysis approaches.