CHAPTER I
INTRODUCTION

Nowadays, petroleum-based materials are one of the most important materials due to their diverse properties. However, due to increasingly difficulty in locating new petroleum resources, many researchers have been trying to optimize the use of the products derived from these materials, by looking for alternative materials from renewable resources. Natural and biologically-derived materials are very attractive due to environmental concerns and natural abundance, so as to completely replace or minimize the use of the petroleum-based products. Instead of completely replacing the use of petroleum-based materials, there are ways to improve the properties of the materials, through physical and/or chemical modification, physical blending, or composite processing. The basic concept of blending and composite processing is similar (i.e., combination of two or more materials together), but the difference is that the minor phase (reinforcing or filling materials) of the composites will not undergo a phase transition during the mixing process. Generally, the reinforcing or the filling materials can be of either organic or inorganic origins, which make composites very diverse materials to work with. Due to natural abundance, the use of organic materials as reinforcing or filling materials in the composites is of high interest here.

Generally, mechanical and thermal properties of polymers are dictated by their morphology, of which major concern is about the structural states (i.e., amorphous or crystalline, crystalline form, degree of crystallinity, etc.) of the polymers. In the case of composites however, there are even more parameters, contributing to the overall properties of the materials, such as the distribution and the morphology of the minor phase, interaction between the minor phase and the matrix, and so on. Therefore, the overall properties of the composites are mainly controlled by the properties of the reinforcing, minor phase. Nowadays, composites are used in many fields because of two reasons. The first is due to an attempt to lower the overall price of the polymer product, through simple mixing of cheap filler in the polymer during processing, without compromising the overall properties of the resulting product. In this case, the reinforcing materials are chosen based mainly on their

prices. The second is an attempt to fabricate composite materials with enhanced properties, without the need to totally synthesize a new material. In this aspect, the chemical and physical characters of the fillers as well as their state of mix within the matrix are of prime concern in order to achieve the objective of having new materials with enhanced properties.

Firstly, in Chapter II, review about basic concept of composite materials is briefly addressed. In addition, the concept of Slap model and Halpine-Tsai model in predicting the mechanical properties of conventional composite materials is discussed.

In Chapter IV, an example of a macro-composite which was designed to reduce the cost of injection-molding articles from iPP by incorporating natural, roselle fibers was presented. The effects of type, size, and amount of the roselle fibers on the mechanical properties in the injection-molded iPP/roselle composites were studied. The morphology of the roselle fibers and microstructure of the impact-fractured surface was investigated by scanning electron microscope (SEM). An Instron 4206 universal testing machine was the main technique used to investigate the mechanical properties of the composites according to the ASTM D 638–91 standard test method. Moreover, Izod impact resistance of these composites was determined using a Swick 5113 impact tester according to the ASTM D 256–90b standard test method. This chapter shows the incorporation of the natural fibers could improve certain mechanical properties of the composites.

In Chapters V and VI, the nano-composite system of electrospun PVA fibers, filled with nanocrystalline structure that had been derived from shells of shrimps, i.e., chitin whiskers, was investigated. Morphology of both the neat and the chitin whisker-reinforced PVA fiber mats was observed by a JEOL JSM-5200 scanning electron microscope (SEM), while the average diameter of the individual fibers within the mats was determined from SEM images, from which at least 300 fibers were measured for their diameters using an image-analytical software. Chitin whiskers which have a very high strength were introduced into these nanofibers with an aim of improving the mechanical properties of the PVA nanofibers. The success of the preparation of nanocomposite nanofibers was proved by a Thermo Nicolet Nexus 671 Fourier-transformed infrared spectroscope (FT-IR) and a TGA 2950

DuPont thermogravimetric analyzer (TGA). The static mechanical properties of the nanocomposite nanofibers were investigated using a Lloyd LRX universal tester according to the ASTM D882 standard test method, while the dynamic mechanical properties of these nanocomposites were also evaluated and reported.

In the Chapter VII, the micro-composite system of PVA films, filled with the nylon 4, 6 nanofibers which were prepared by electrospinning process, was investigated. Morphology of nylon 4, 6 as-spun fibers was observed by a JEOL JSM-5200 scanning electron microscope (SEM), while the average diameter of the individual fibers within the mats was determined from SEM images, from which at least 3000 fibers were measured for their diameters. The percent of nylon 4, 6 as-spun fibers in the composite were measured using thermogravimetric analyzer (TGA). The surface area and porosity of nanofibers were investigated using N_2 adsorption/desorption isotherms which were obtained by BET. The Rigaku X-ray diffractometer (XRD) was used to study the crystal structure of nylon 4, 6 in these composites. The static mechanical properties of the nanocomposite nanofibers were investigated using a Lloyd LRX universal tester according to the ASTM D882 standard test method. Moreover, Halpin-Tsai model was applied to these composites and compare with the experimental data were shown.