CHAPTER 1

INTRODUCTION

1.1 GENERAL INTRODUCTION

The use of natural fibers in more diversified fields came alongside the emergence of polymers in the 19th century. This followed the success of the German Chemist Hermann Staudinger's ability to prove his earlier proposed hypothesis about polymers to be true. At the same time, researchers also developed interest in synthetic fibers due to their superior dimensional properties, making it to slowly replace the natural fibers in several applications. However, fabrications of synthetic fiber reinforced polymer composites required a lot of energy, as well as pollute the environment especially during production and recycling (Mohanty et al., 2005).

This again brought attention back to the natural fibers based on their distinct advantages (Mohanty et al., 2005; Wambua et al., 2003). The renewed interest therefore opened grounds for a large number of modifications to bring the natural fibers at par, and where possible superior to the synthetic fibers. These modifications therefore made natural fibers suitable for such applications as packaging, medicine, furniture and automatic parts (Rijswijk & Brouwer, 2002, Nickel et al., 2003; Netravali et al., 2003; Marsh, 2003; Wambua et al., 2003; Suddell and Evans, 2003; Schloesser, 2004; Mathur, 2006). Hydrophilic character of natural fibers however led to composites with weak interface but pre-treatments were sought, which aims at improving the adhesion between fibers and polymer matrices.

In pre-treatments, either the cellulose hydroxyl groups of the fiber get activated or new moieties are added that can effectively interlock with the matrix (Khalid et al., 2008; Cabedo et al., 2006). Despite this necessity for surface treatment in order to obtain desirable results from natural fiber reinforced polymer composites, the unique attribute of natural fibers, such as being less abrasive to processing equipment as well as reduced respiratory tract related problem for worker, makes them highly esteemed (Bledzki et al., 1999; Mohanty et al., 2000; Kandachar, 2002; Mohanty et al., 2002; Evans et al., 2002; Sanadi, 2004, Maya and Thomas, 2008). Moreover, they are less expensive and also possesses good load bearing potential which contributes to its wide spread application in several sectors such as aircraft, construction, storage facilities and even in foot wears. In countries where improved sustainability is legislation due to environmental consciousness, there is high priority to the incorporation of lignocellulosic fibers in polymer composites especially in automotive applications (Bledzki et al., 2002; Evans et al., 2002). Among the various natural fibers; flax, bamboo, sisal, hemp, ramie, jute, oil palm and wood fibers are of particular interest.

Oil palm (*Elaeis guineensis Jacq.*) is one of the oil crops in the world that produces the largest quantity of edible oil. Cultivation of oil palm has an extension of over 42 countries with an estimated value of about 11 million hectare on a worldwide basis (Khalil et al., 2008). Some countries which possess the largest areas for oil palm cultivation includes West African countries like Nigeria, South East Asian countries like Indonesia and Malaysia, Latin America countries and India (Joseph et al., 2006). The estimated amount of dry matter produced from an annual oil palm plantation is about 55 ton per hectare, in form of fibrous biomass alongside an equivalent 5.5 ton of oil (Hasamudin and Soom, 2002).

Apart from palm oil which is the main product from palm oil industries, vast quantities of biomass from which fibers can be obtained are also produced. The fibers can be gotten either from the palm frond, palm trunk, fruit mesocarp and especially oil palm empty fruit bunch (EFB). Oil palm empty fruit bunch is the fibrous mass which remains after palm fruits had been separated from the fruit bunches. Oil palm empty fruit bunch had been said to possess a yielding capacity of up to 73% fibers; higher than other sources in the oil palm industry (Wirjosentono et al., 2004). This led to the preference of EFB both in terms of availability as well as cost (Rozman et al., 2000). Oil palm empty fruit bunch is a hard and tough fiber which is in many ways similar to coir fibers (Ibrahim et al., 2005). Surface of EFB fibers has many pores which offer it good interlocking properties with polymer matrix during composite fabrication. However the presence of porous surface morphology could lead to high water absorption by the action of capillary whenever it is exposed to water (Hill and Khalil 2000). Analysis of EFB would reveal some granules of starch on the interior of the vascular bundle (Law et al., 2007).

Report from several authors had shown that oil palm empty fruit bunch fiber, among several other natural fibers had been used to reinforce polymers in different applications and at varying degrees. A notable example is the incorporation of natural fibers into thermoplastics like PLA, wherein the issue of fiber matrix interaction is always contentious from one researcher to another (Bax & Müssig, 2008; Bledzki, et al., 2009; Huda et al., 2006; Huda et al., 2008; Huda et al., 2005; Mathew et al., 2003; Petersson et al., 2007; Petinakis et al., 2009; Plackett et al., 2003; Suryanegara et al., 2009; Sykacek et al., 2009; Van de Velde & Kiekens, 2002). However, most of these researches show that there is apparently poor adhesion between the fiber and the PLA matrix interface, hence the need for further modifications to improve the surface interaction of EFB fibers and PLA matrix. The essence of surface modification is to make the hydrophilic fiber become more susceptible to the hydrophobic polymer matrix through surface treatment of the fiber. This is to enhance fiber matrix interaction which is a major perquisite for composites in which mechanical, tensile, abrasive and other desirable properties are priorities. There is this possibility through surface treatment, in which case the hydroxyl groups get activated or through the addition of new moieties that can interlock effectively with the polymer matrix.

Several modifications have been made on fiber surface in times past, and their effect noted. These studies have been undertaken to modify the performance of natural fibers in varying degrees. Different surface treatment methods such as alkali treatment (Chang et al., 2009), isocyanate treatment (Maiti et al., 2004,) acrylation (Huda et al., 2008), benzoylation (Mohanty et al., 2001), latex coating (Sreekala, 2000), permanganate treatment (Joseph, 2000), acetylation (Larsson-Brelid et al., 2008), silane