Chapter 12
Simulation of Fragmentation Technique Using ANSYS Software

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ABSTRACT

This chapter addresses the proposal of fragmentation test and its simulation using ANSYS software owing to understand the interfacial adhesion of natural fibre with synthetic matrix. Date palm fibres and epoxy materials are selected for the study. The influence of NaOH concentration and fibre diameter on the interfacial adhesion of the fibre with the epoxy are studied. The results indicated that the addition of the fibre to the matrix significantly improved the mechanical properties of the composites. However, an optimum value for the chemical concentration and the fibre diameters should be considered in developing such materials. High NaOH concentration deteriorates the tensile strength of the fibre. Meanwhile, low NaOH concentration exhibits poor interfacial adhesion.

1. INTRODUCTION

In the recent years, the awareness of environmental protection is the concern of many engineers and researchers. Thus, the importance of alternative, sustainable materials and renewable technologies should no longer be a debating topic, (Hawken, Lovins, & Lovins, 2010; Michaelides, 2011). There are many ways to contribute to this paradigm shift. One of these ways is to develop composite materials as an alternative for metallic and non-metallic materials for the industrial applications. Scientist and engineers have effectively explored opportunities to develop sustainable polymer composites which were taken to minimize the environmental impact and to overcome the dependence petroleum resources, (Lepech, 2009; Silva, Alves, Ferreira, Oliveira, Reys, Ferreira, Sousa, Silva, Mano, & Reis, 2012). Recently, after the noticeable advancement of materials' research and the

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advent of the introduction of leading edge fabrication techniques, the application of bio-composite materials in modern engineering technology is widely spread across industries; not limited to environmental protection and the maintenance of physical health,(Gottlieb, 2002; Sabo, Jin, Stark, & Ibach, 2013; Vroman & Tighzert, 2009). The literature has clearly demonstrated that there is it an interest in using natural fibres as reinforcements for polymeric composites. However, there are several limitations which adversely influence the use of such bio-fibre in composites. One of the main issues is the interfacial adhesion of the fibre with the matrix. In the recent years, a few attempts have been done to study the interfacial adhesion of the fibre with the matrix. The mechanical efficiency of the fibre-reinforced polymer composites depends on the fibre-matrix interface and the ability to transfer stress from the matrix to fibre as reported by many researchers, Moisture absorption, impurities, orientation, volume fraction and physical properties of natural fibres play constitutive role to determine the mechanical properties of fibre polymer composites. (Bledzki & Gassan, 1999). In some reported works, it has been found that there is a correlation between the mechanical properties of the composites and their wear and frictional performance. Therefore, this research will focus on both mechanical and tribological characteristics of the newly developed composites. The following sections will explain the influence of some important elements on the mechanical properties of the natural fibre/ polymer composites followed by the tribological ones (Shalwan & Yousif, 2012).

Mechanical properties of polymeric composites based on natural fibres strongly depend on the interface between the fibres and the polymer matrix. This is mainly due to the fact that natural fibres are rich in cellulose, hemicelluloses, pectin's and lignin which are hydroxy1 group, natural fibres tend to be strong polar and hydrophilic materials whilst polymers exhibit significant hydrophobicity. In other words, there are significant problems of compatibility between the fibre and the matrix, i.e. weak interface between natural fibres and matrices (Alves, Ferrão, Silva, Reis, Freitas, Rodrigues, & Alves, 2010; Azwa, Yousif, Manalo, & Karunasena, 2012). However, many investigators reported that chemical treatments as bleaching, acetylating and alkali treatment can improve the matrix-fibre interfacial adhesion the mentioned chemical treatment is a process of cleaning the fibre surface from impurities that in turn increases the roughness of the fibre surface and also by disrupting the moisture absorption process through of coat of NaOH groups in fibre. Several works have been done to study the influence of the type and concentration of chemical solution on the fibres' characteristics and their interfacial adhesion with various matrices. For example, investigated the effects of two kind of chemical treatments in deferent concentrations are (NaOH 0.5-5% and HCL 0.3-1.6N) on surface morphology, and mechanical properties of date palm fibre (DPF). The results of that work revealed that NaOH has enhanced surface morphology of fibre and increase the number of pores on fibre surface during the increase of concentration. This could be owing to increase the cruelty of reaction of NaOH on fibre whenever increasing the soda concentration, (Jandas, Mohanty, & Nayak, 2013; A Shalwan & Yousif, 2012). Also, the tensile strength and young's modulus of the DPF have been enhanced when alkali treatment applied at all concentrations compared with untreated DPF. The optimum alkali concentration was at 1% where enhance the tensile strength 300% compared with untreated DPF (Dumitriu, 2002). This might be attributed to attack the solution the main construction components as alkali concentration increase which lead to appear grooves on the surface of fibre and weaken in fibre strength. On the other hand, HCL treatment had high reduction in the tensile