Properties of Natural Fibres for Composite Materials

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SUMMARY

Natural fibres, particularly those which form a waste material from other industries, are of interest to manufacturers as an easily sourced material, from which it is possible to produce a composite material. The current work suggests that an effective energy absorber could be produced from a natural fibre feedstock.

Keywords: Natural fibres, Weibull statistics, energy absorption

Introduction

Natural fibre composites whether using a bio-derived polymer or standard resin system are of interest for the production of comparatively low or even negative carbon footprint materials. Waste materials such as wood flour or sawdust have been used as a filler or to make "synthetic wood" e.g. [1] but even this relatively mature area is still of interest, particularly in the context of using recycled or post-primary use polymers [2].

At longer length scales flax, jute and other such natural fibres have been investigated and reviewed e.g, [3] The fibres used in the current work are waste from palm oil production and have been found to have interesting properties. The current work represents a characterisation study prior to the production of composite materials.

Microscopy

One of the key issues with natural fibres is the lack of uniformity in the basic material. Figure 1 demonstrates a number of the issues involved, such as, when attempting optical microscopy, the issues in attempting to focus on a surface that is both rounded and of non-uniform cross-section. Hence, the edges are rarely both in focus at the same time. Other issues include varying cross-section (Fig. 1a); branching or splitting of the fibre (Fig. 1b) and variations in the internal microstructure (Fig. 1c and d).

Mechanical Properties

As can be seen in Figure 2, the fibres are capable of achieving reasonable stresses-to-failure (the average failure stress is 60 MPa, with a standard deviation of 20 MPa) but of more interest is the strain to failure of these fibres which is typically of the order of 8 ε%. Whilst the fibres cannot be described as brittle, the fit to a two parameter Weibull model is good, which suggests that this is a useful way of modelling the properties of these fibres. The force-displacement from which Fig. 2a is derived suggests that each fibre can absorb some few hundredths of a Joule. Whilst this does not seem that significant, given the size of the fibres this would equate to an energy absorption of several mega-Joules per cubic metre of material. Hence, if a suitable interface between matrix and fibre can be achieved without degrading the fibres, a cheap energy absorbing composite could be produced.

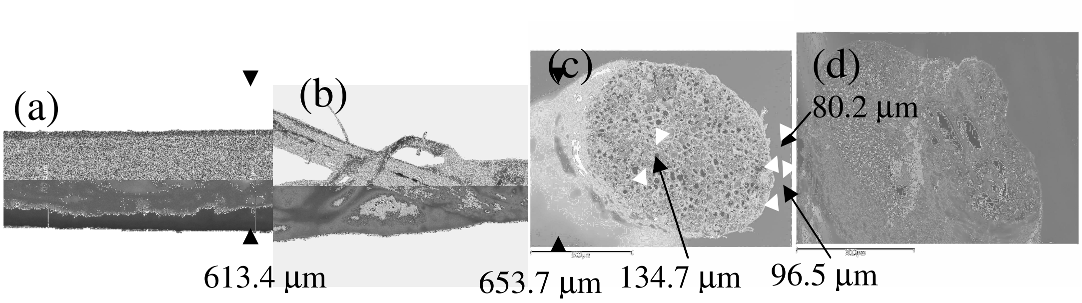

Figure 1 – Optical (a and b) and Scanning Electron (c and d) Micrographs of Oil Palm Truck Fibres: Fibres are non uniform in width (a), have occasional bundling or splitting (b), and the internal cross-section displays varying internal microstructure (c and d)

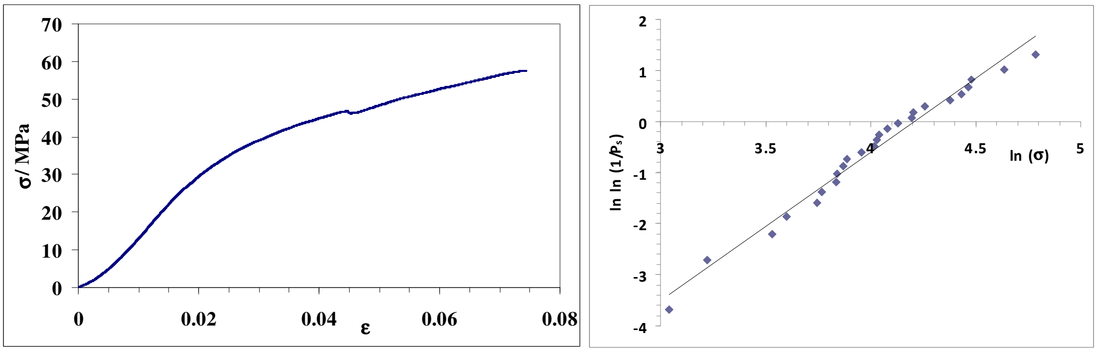

Figure 2 – Examples of a) typical stress-strain curve and b) Weibull Plot

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References

1. S. N. Maiti, K.S., *Influence of wood flour on the mechanical properties of polyethylene.* Journal of Applied Polymer Science, 1986. **32**(3): p. 4285-4289.
2. Huda, M.S., et al., *Wood-fiber-reinforced poly(lactic acid) composites: Evaluation of the physicomechanical and morphological properties.* Journal of Applied Polymer Science, 2006. **102**(5): p. 4856-4869.
3. Mohanty, A.K., M. Misra, and G. Hinrichsen, *Biofibres, biodegradable polymers and biocomposites: An overview.* Macromolecular Materials and Engineering, 2000. **276**(3-4): p. 1-24.