Fractographic observations of the microstructural characteristics of flax fibre composites

Natural fibre composites possess a number of special microstructural characteristics, which need to be documented to aid in the further development of these materials. Using field emission scanning electron microscopy, fractographic observations of the microstructural characteristics of aligned flax fibre/thermoplastic composites are presented. The findings are presented in relation to the three operational parts in composites: fibres, matrix and fibre/matrix interface. For the flax fibres, the striated structure on the fibre surface is shown to consist of cellulose macrofibrils oriented in the fibre direction, which indicates that the external primary and secondary cell wall layers (P and S1) have been removed during fibre processing, leaving the S2 layer to form the outer surface. The observed fracture surfaces of the flax fibres support a previously proposed failure mechanism of transverse failure followed by longitudinal splitting. For the thermoplastic matrix, concentric rings with different points of origin are observed in the matrix regions of the composite fracture surface. The concentric rings have a microporous structure consisting of nanoscale polymer fibrils. The concentric rings form mirror zones with no riverlines, followed by repeated mist and hackle zones with distinct radiating riverlines. For the flax fibre/thermoplastic matrix interface, microscale imprints of whole fibres, and nanoscale imprints of fibre surface structures are observed on the matrix surface. This demonstrates a good fibre/matrix compatibility enabling the two parts to be in intimate contact. The composite fracture surfaces show fibres that have been pulled-out in different lengths, in addition to fibres that have failed in the same plane as the fracture surface. Altogether, the present study provides novel observations, measurements and interpretations to be used in the further analysis and understanding of the properties of natural fibre composites. (C) 2015 Elsevier Ltd. All rights reserved.

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