156b Truly Green Composites: Fibre, Polymer & Interface Characterisation

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Truly Green Composites: Fibre, Polymer & Interface Characterisation

Increasing environmental awareness, growing global waste problems, the continuously rising high crude oil prices motivated governments to increase the legislative pressure, such as the European Union End-of-Life Vehicles (ELV) and Waste Electrical and Electronic Equipment (WEEE) Directive. This in turn prompted researchers, industry and farmers to develop concepts of environmental sustainability and reconsider renewable resources. As a result, the composite and polymer manufacturers, the processing industry and end-users but also the local communities will need to move away from traditional engineering materials for certain applications. New strategies will have to be developed for environmentally and economically viable materials manufacturing and processing, but also reuse and recycling. Composites with moderate strength will perform for many non-critical structural applications in the automotive and electronic, but also for packaging, housing and building industry. Green (incl. nano) composites made entirely from renewable agricultural resources could offer a unique alternative for these applications. The development of green and compostable composites for vehicle parts for will enable to eliminate waste. Any waste not recycled inside the production process, plus any waste from product use or disposal can be diverted 100% from landfill using to a composting process. In the UK alone there currently 2 million vehicles per annum are scrapped of which approx. 9% by weight are polymers, the vast majority of which is currently landfilled. As about 17% of a vehicle is landfilled, the potential is a 50% saving by diverting waste to composting. Composites are combination of at least two distinctively different materials, which combined together provide an engineering performance that by far exceeds those of any individual component. It is the quality of the interface between the components that determined the mechanical and chemical performance of the composites. As for all composites a good adhesion between the fibres and the matrix is prerequisite for optimal load transfer from the matrix into the fibres. The knowledge of the fibre surface properties will help to optimise the interactions between the fibres and the matrix. We will present our results on the surface and bulk characteristics of several natural fibres as studied by wetting and zeta-potential measurements and single fibre tensile testing. The wetting behaviour of the natural fibres is characterised by measuring the wetting rates (penetration velocities) of a series of liquids using the capillary rise technique. The fibre surface tensions are estimated from plots of the normalised wetting rate as a function of the surface tension of the liquids assuming, in analogy to Zisman's method, that the maximum of the normalised wetting rate corresponds to the solid surface tension. The estimated surface tensions of investigate natural fibres indicate that most fibre surfaces are quite “hydrophobic” due to the presence of protecting wax layers. An atmospheric air plasma treatment enhances the wetting behaviour and leads to a drastic increase in the fibre surface tension. Zeta potential measurements using the streaming potential method were performed in order to study the water uptake behaviour as well as the acid/base surface properties of several natural fibres. The influence of an atmospheric plasma treatment on the surface properties of the fibres will be characterised. The time-dependence of the zeta-potential, measured in 1 mM KCl solution, offers an alternative possibility to estimate the water uptake behaviour for nearly all investigated natural fibres. The water uptake data derived from the zeta-potential measurements are compared with conventional water adsorption studies. The adhesion behaviour between the fibres and a biodegradable polymer will be directly measured using the single fibre fragmentation test. Our study presents the first cycle of a materials selection and optimisation process for the development of a truly green composite with satisfying mechanical performance.