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Editorial corner – a personal view
Are hierarchical composite structures the way forward to improve the properties of truly green composites?

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Rising oil prices, exhaustion of landfill sites emphasise end-of-life problems associated with traditional materials and have triggered fresh interest in polymer and composite end-of-life and recycling issues. Consumer demands for more environment-friendly goods and intensifying legislative pressure for greener, carbon neutral technologies are forcing materials manufacturers to consider the environmental impact of their products. Consequently, the composite industry is seeking greener materials that match the physical performance of traditional ones. Renewable polymers often have inferior properties to their synthetic counterparts. Developing composites is thus a vital strategy for enhancing the performance of these polymers. In order to create a new generation of environmentally superior polymer composites, it is necessary to replace synthetic fillers with renewable ones.

Natural fibres are used for various applications. However, simple fibre reinforcement of renewable polymers has failed to achieve the performance of conventional composites. New green reinforcing agents, such as bacterial cellulose fibrils produced by various bacteria may provide a breakthrough. Bacterial cellulose fibrils have diameters ranging from 10 to 100 nm and a measured Young's modulus of 78 GPa, which is comparable to that of glass fibres but at a lower density. In addition to its lightweight and attractive mechanical properties, bacterial cellulose is non toxic, renewable and biodegradable. These intrinsic properties can be used to influence and enhance the matrix performance.

Nature demonstrates the use of hierarchical structures when high mechanical resistance is needed, e.g. in plant cell walls, animal shells and bones, through the assembly of molecules of different sizes. The application of this concept is markedly improving our engineering of *truly green* composites. Nanocellulose coated natural fibres were created by cultivating cellulose-producing bacteria in the presence of fibres, resulting in significant coverage of the fibre surfaces by bacterial cellulose. We have created hierarchical structures in natural fibre composites by using these 'hairy' fibres to deliver the nanoreinforcement into polymer matrices, avoiding troublesome processing issues associated with anisotropic nanofillers. There are some outstanding issues in hierarchically structuring composites: the compatibility between all phases, the arrangement of the nanofiller within the composite, and biodegradability control. The separation of end-of-life waste of *truly green* composites from the waste streams and compositing is another thorny issue.

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