Development of Tailor made Green Packaging Plastic-Thermal, mechanical and biodegradation studies

Executive summary

As an eco-friendly alternative to synthetic plastics, The Energy and Resources Institute (TERI), developed a tailor-made biodegradable plastic. Blends of commonly used synthetic thermoplastics, such as Low Density Polyethylene (LDPE), polystyrene (PS) and poly (methyl methacrylate) (PMMA) were blended with a natural biopolymer like starch, cellulose, or lignin. In order to enhance the biodegradability, high loadings (>40%) of the natural biopolymer is essential. However, as the biopolymeric loading increases, the mechanical properties are reduced and the blend becomes hydrophilic, owing to the poor interfacial adhesion between the nonpolar polymer matrix and the polar biopolymer. Therefore, modification of the synthetic polymer, or the biopolymer, or both, is essential to improve the mechanical properties and to allow enhanced loading of the biopolymer without jeopardizing the blend properties too much.

In this study, loading of biopolymer varied from 20% to 60%. A pro-oxidant, i.e. zinc stearate, was also added to facilitate auto-oxidation of the matrix. The interfacial adhesion was enhanced by using functionalized polymer. Further increase of biopolymers, such as starch loading up to 90% was also developed by using crosslinked starch and a mixed plasticizer system. Silane modified nanoclay was used as a reinforcing filler.

Experiments conducted on the use of modified biopolymeric materials with nanoclay, were studied without the use of synthetic polymers. Therefore, esterfication crosslinking and/or plasticization was carried out prior to blending them with silane treated nanoclay. The effect of using a miscible biopolymeric nano blend system was also investigated for mechanical, thermal, water absorption, and biodegradable characteristics.

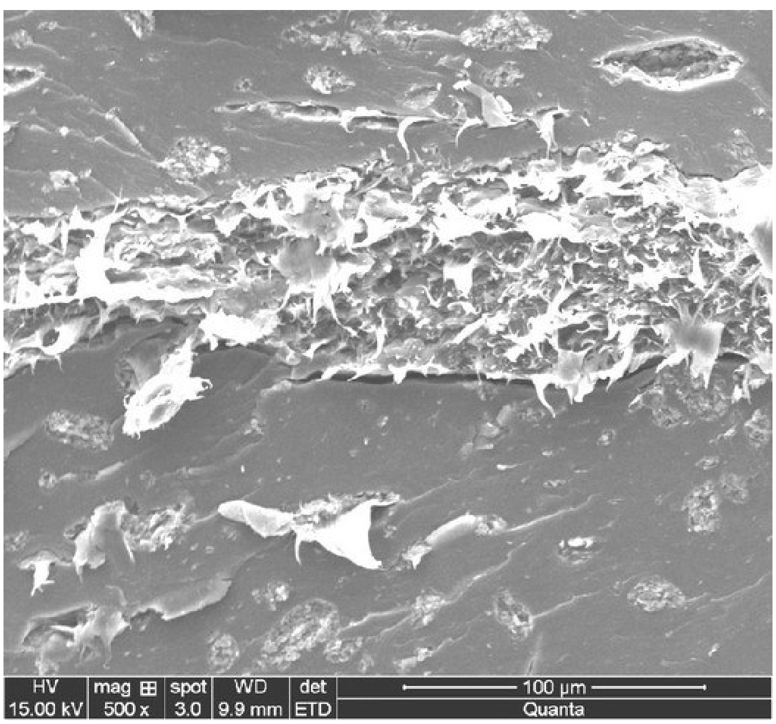
The partially bio-based composites improved considerably by the addition of a compatibilizer. The crosslinking of biopolymeric materials was found to be promising and exhibited considerable improvement in its mechanical strength.

These materials can be scaled up and used for packaging purposes, cutlery and for ‘use and throw’ applications etc.

Uncrosslinked StPh
(rough and uneven)

Cross-linked
StPh

Crosslinked StPh/ 6% NC (smooth glossy finish)



SEM micrograph of fractured surface with 5% NC