Nanolatexes: a versatile toolbox for cellulose modification

Abstract

Cellulosic materials are widely used in our everyday lives, ranging from paper and packaging to biomedical applications. However, in most applications, cellulose must coexist with hydrophobic polymers which can be challenging due to its hydrophilic character. A versatile way to modify cellulosic materials is through the physical adsorption of highly tailorable colloidal nanoparticles synthesized in water, called nanolatexes. Their synthesis is based on the combination of the reversible addition-fragmentation chain transfer (RAFT) polymerization with polymerization-induced self-assembly (PISA). The bridging of these techniques results in the formation of amphiphilic di-block copolymers which self-assemble in water forming a variety of morphologies.

A fundamental investigation of the parameters that govern the adsorption of cationically charged nanolatexes onto silica and regenerated TEMPO-oxidized cellulose model surfaces was performed. The combination of gravimetric and reflectometric techniques revealed the complexity of that cellulosic model surface, where both the size and the charge density of the nanolatexes were found to influence their adsorption. The information gained from this study was implemented in the preparation of cellulose nanofibril (CNF)-nanocomposites with low contents of nanolatexes. It was found that when the nanolatex content was below 1 wt% the mechanical profile of the CNF-nanocomposites was improved.

In an attempt to address the increasing demand for the replacement of fossil-based with bio-based alternatives, wood-based nanolatexes were also prepared. Their successful adsorption onto cellulose filter papers, followed by their annealing, demonstrated their film formation capacity. The same nanolatexes were also used as model colloids to study their penetration on CNF networks before and after annealing by grazing incident small angle X-ray scattering (GISAXS).

The results of these studies, add to the understanding on physical modification of cellulose and are envisaged to further promote the utilization of wood-based monomers in the production of the polymers for high-end applications.