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PROCESSING OF POLYMER NANOCOMPOSITES REINFORCED WITH POLYSACCHARIDE NANOCRYSTALS

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Owing to the hierarchical structure and semicrystalline nature of polysaccharides (cellulose, starch and chitin), nanoparticles can be extracted from these naturally occuring polymers. Native cellulose and chitin fibers are built up by smaller and mechanically stronger long thin filaments, the microfibrils consisting of alternating crystalline and non-crystalline domains. Multiple mechanical shearing actions can be used to release more or less individually these microfibrils. This material is usually called microfibrillated cellulose when using cellulose. Longitudinal cutting of these microfibrils can be performed by submitting the biomass to a strong acid hydrolysis treatment, allowing dissolution of amorphous domains. The ensuing nanoparticles occur as rod-like nanocrystals or whiskers. Similar acidic treatment carried out on starch granules allows obtaining platelet-like nanoparticles. Impressive mechanical properties and reinforcing capability, abundance, low weight, and biodegradability of cellulose nanocrystals make them ideal candidates for the processing of polymer nanocomposites. With a Young's modulus around 150 GPa and a surface area of several hundred $m^2.g^{-1}$, they have the potential to significantly reinforce polymers at low filler loadings. However, as for any nanoparticle, the main challenge is related to their homogeneous dispersion within a polymeric matrix. Polysaccharide nanoparticles are obtained as aqueous suspensions and most investigations focused on hydrosoluble (or at least hydrodispersible) or latex-form polymers. The possibility of dispersing these nanocrystals in non-aqueous media can be obtained using surfactants or chemical grafting and it opens other possibilities for nanocomposites processing. Polysaccharide nanocrystals possess a reactive surface covered with hydroxyl groups, providing the possibility to extensive chemical modification. Small molecules or long chains can be grafted. For the latter either "grafting onto" or "grafting from" approaches can be used. Very few studies have been reported concerning the processing of polysaccharide nanocrystals reinforced nanocomposites by extrusion methods.