Polymer composites based on nanocrystalline cellulose

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Green composites can be obtained by combining matrix and fillers derived from natural resources. Cellulose, which is a semi-crystalline polysaccharide contained in plant cells, is widely available. Nanocrystalline cellulose (NCC) can be isolated from cellulose fibers though acid hydrolysis. NCC ranges from 100-1000 nm in length and from 5-60 nm in diameter. NCC exhibits a longitudinal elastic modulus of about 140 GPa which makes it suitable for mechanical reinforcement in polymers. However, NCC is highly hydrophilic, rendering its incorporation in polymers problematic. By now, the use of NCC has mainly been restricted to hydrophilic matrices: composites were either prepared via a solution process in water or via a latex. Some authors [1, 2] prepared polylactide (PLA)/NCC composites by extrusion, feeding the NCC in a suspension form. The composites exhibited poor performance which was attributed to the presence of residual solvent. Polyethylene (PE)/NCC composites were prepared by extrusion, feeding the NCC in a powder form [3]. A significant improvement of elongation at break was observed when NCC was modified with a proper organic treatment. This result was related to a better dispersion of the filler. In this work, we incorporated pristine NCC and organophilic NCC in PLA and PE matrices by micro-extrusion. The dispersion state was analyzed by electron microscopy. The thermal and mechanical properties were analyzed by DSC and DMA. The effect of the addition of a coupling agent (PLA-g-MA or PE-g-MA) was also investigated. [1] K. Oksman, A.P. Mathew, D. Bondeson, I. Kvien, Composites Science and Technology, 66, 2776–2784 (2006). [2] D. Bondeson and K. Oksman, Composites: Part A, 38, 2486–2492 (2007). [3] A.J. de Menezes, G. Siqueira, A. A.S. Curvelo, A. Dufresne, Polymer, 50, 4552–4563 (2009).