Incorporation of microfibrillated cellulose in polymers via twin-screw extrusion

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Natural fibres are increasingly used to reinforce polymers [1] due to their renewable origin, low density, availability and low price. Wood and plants contain cellulose molecules which form microfibrils (diameter of 4-35 nm) with properties such as high aspect ratio, Young's modulus around 140 GPa [2] and gel formation in water. Mechanical shearing (homogenization) was used to defibrillate cellulose suspension into microfibrillated cellulose (MFC) gel composed of microfibrils and microfibril bundles in view to be incorporated, after drying, in polymers by melt processing. However it is first strongly advised to apply surface treatment or coating to MFC before drying to avoid formation of agglomerates by hydrogen bonding [3]. Moreover thermal stability, critical in melt processing, of cellulose fibres and dried MFC was found to be different [4]. Low molecular weight PP-g-MA suspensions and PEG were used as coating agent to disperse MFC in polyolefins and poly(lactic acid). Lab and semi-pilot scale twin-screw extruder were used to elaborate the composites. The benefit of pressurized water injection during extrusion [5] was attempted for MFC-polyolefin composites. Morphological characterization of the composites exhibited a defibrillated structure. Rheological properties of coated MFC composites showed a percolating effect which was not observed with starting cellulose fibres and untreated MFC. This phenomenon was due to the interconnected network of microfibrils in the polymer. Mechanical properties of coated MFC composites were characterized by DMA and tensile tests and compared to cellulose fibres and untreated MFC composites. References: [1] M. Bengtsson, M. Le Baillif, K. Oksman, Composites: Part A, 38, 1922-1931 (2007). [2] I. Sakurada, Y. Nukushima, T. Ito, J. Polym. Sci., 57(165), 651-660 (1963). [3] L. Heux, G. Chauve and C. Bonini, Langmuir, 16, 8210-8212 (2000). [4] N. Quiévy, N. Jacquet, M. Sclavons, C. Deroanne, M. Paquot, J. Devaux, Polym. Degrad. and Stab., In Press, Accepted Manuscript, Available online 26 November 2009. [5] J. Soulestin, N. Quiévy, M. Sclavons, J.Devaux, Polymer Engineering and Science, 47(4), 467-476 (2007)