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Effect of acetylation on the thermal properties of cellulose nanocrystals

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Abstract: Cellulose is one of the most abundant bio-polymer on the Earth. Cellulose nanocrystals are obtained from cellulose by acid hydrolysis. Sulfuric and hydro-chloric acids are mostly used for cellulose nanocrystals production by hydrolysis reactions. The potential application of cellulose nanocrystals is as reinforcing materials in thermoplastics polymer composites. There are some drawbacks using cellulose nanocrystals as reinforcement in the thermoplastic composites. The first drawback is the low compatibility between the hydrophilic cellulose nanocrystals and the hydrophobic polymer. The second drawback is the low thermal stability of cellulose nanocrystals due to sulfate groups. During the hydrolysis reactions with sulfuric acid treatment, sulfate groups are created on the surface of cellulose nanocrystals. Several previous studies reported that these residual sulfate groups had detrimental effect on the thermal stability of cellulose nanocrystals. When cellulose nanocrystals are used as reinforcement in the thermoplastic composites, they are exposed to high temperatures (180°C and above) during the manufacturing process. In earlier studies, it was reported that acetylation of lignocellulosic fibers improved thermal stability of the fibers and the compatibility between hydrophilic lignocellulosic fibers in hydrophobic thermoplastic matrices. In this study, in order to understand the effect of acetylation on the thermal properties of cellulose nanocrystals, thermal degradation of cellulose nanocrystals and acetylated cellulose nanocrystals have been investigated using thermo-gravimetric analysis (TGA) between room temperature and 700°C. It was found that acetylated cellulose nanocrystals were more thermal stable than untreated cellulose nanocrystals and the chemical modification played an important role in the thermal decomposition process.
Keywords: Acetylation, Cellulose, Cellulose nanocrystals, Thermo-gravimetric analysis