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Cellulose-Based Functional Materials

Cellulose, as a naturally occurring biopolymer, has received much attention for its possibilities to be used as a starting point for advanced bio-based materials. By chemically modifying the structure of cellulose it is possible to create materials with desired properties and functionalities. These can be eg. porosity, selectivity or responsiveness to external stimuli, and the respective functionalities could be utilized as pH-sensitive drug-releasing materials or a barriers with selective permeability. From an ecological point of view, the use of cellulose and its derivatives can provide alternatives for the widely used synthetic and oil-based polymers, such as plastics.

In this work derivatization of cellulose is done chemically, introducing ester-, ether- or carbamate moieties to the starting material. The aim is to utilize these well-known routes of modification to form products with new and beneficial properties. So far cellulose-fatty acid esters and cross-linked cellulose carbamates (Illustration 1.) have been synthesized for barrier- and gel formation.
The fatty acid esters were prepared from celluloses with varying degrees of polymerization and hemicellulose content, and from fatty acids with varying chain lengths. IR-, ^{1}H-NMR- and ^{31}P-NMR spectroscopies were used to verify the reactions and the purity of the products. ^{31}P-NMR was also utilized to determine the degrees of substitution of the fatty acid derivatized celluloses. The barrier properties were studied in collaboration with VTT.
The cellulose carbamates were synthesized from microcrystalline cellulose and its fatty acid functionalized derivatives. Cross-linking was achieved using di-isocyanates. The DS of fatty acid functionalization and cross-linking ratio were varied in order to investigate the structural features arising from the modifications. The effects of the drying procedure and wettability of the gels were also studied. The products were characterized using IR-spectroscopy, TGA, DSC and SEM.

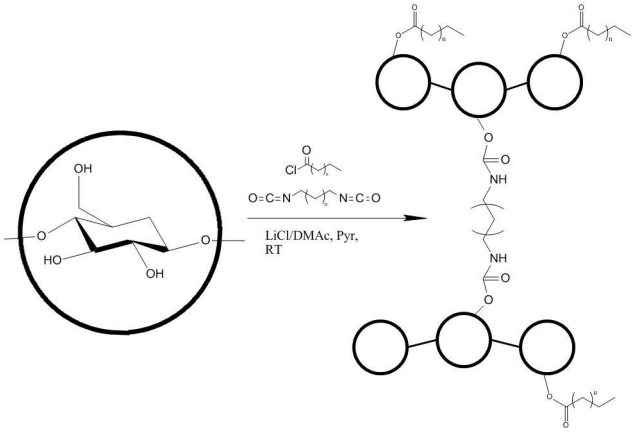

Figure 1. Reaction of cellulose with fatty acid chloride and di-isocyanate.