THERMODYNAMIC INTERACTIONS BETWEEN CELLULOSE NANOCRYSTALS AND BIOPOLYMERS

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Controlling the interactions of nanocellulose with molecules and polymers is key to a more structured approach to developing materials with tailored properties and selective and efficient sensors. We thus started to look into the interaction of nanocellulose with natural polymers such as proteins and hemicelluloses. Protein-cellulose interaction studies will help us to understand the driving force and requirements for interaction with a view on biosensors and more effective enzyme-catalysis. Studying cellulose-hemicellulose interactions on the other hand may prove very helpful in designing moisture-insensitive natural fiber materials and high performance all renewable material nanocomposites.

For our studies [1], we used unmodified and carboxylated cellulose nanocrystals as well as nanocrystals modified with positively charged pyridinium groups with varying level of surface charge. Isothermal titration calorimetric measurements showed that most interactions are entropically driven rather than enthalpically, with binding the result of the collapse of an ordered water molecule structure around the dispersed nanocellulose and the dissolved polymers. These findings indicate that our thinking of nanocellulose-polymer interactions in the presence of water is governed by the water molecules, and to a much lesser extent or even not by preferential interactions between nanocellulose and polymers. Bovine serum albumin (BSA) was also found to interact with 100 cationic surface groups on the nanocellulose surface, irrespective of the density of these cationic groups on the surface. It thus becomes possible to control the conformation of BSA on the nanocellulose surface by tailoring the degree of surface functionality.

Hence, isothermal titration calorimetry (ITC) was found to be a very powerful technique to look into detail into the enthalpic and entropic interactions governing nanoparticle-polymer interactions, which is currently still a largely untapped technique for these applications. The details of our work will be presented to also give everyone an idea of the power of ITC and its potential to elucidate nanoparticle-polymer interactions.

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[1] Lombardo, S. *et. al.*, *Langmuir*, Submitted.