Biomimetic multilayered films based on cellulose nanocrystals

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Biobased nanocomposites are a new class of materials that are attracting growing attention both for economical and environmental reasons. One prerequisite for the building of such structures is the use of well-suited building blocks that both come from renewable resources and possess adequate properties. In this context, cellulose nanocrystals (CNCs) are very attracting candidates that are extracted from renewable and abundant natural resources and that benefit from excellent mechanical properties and low density. Layer-by-layer assembly was thus used to build thin films, consisting of multiple layers alternating CNCs and polymer chains. The polymer associated with CNCs was either a flexible synthetic polycation, Poly (allylamine) (PAH), or a natural neutral polymer that exhibits strong affinity for cellulose called xyloglucan (XG). The architecture of the films was investigated using neutron reflectivity and atomic force microscopy. In both cases, well-defined multilayers and a linear build-up of the film were observed. However, the origin of the interactions, electrostatic for CNCs/PAH and non-electrostatic for CNCs/XG had a strong influence on the structure of the nanocrystals layers. These nanocomposite films reminiscent of plant cell walls are interesting candidates for the preparation of thin biocompatible films with tunable optical or mechanical properties.

Figure 1: Neutron reflectivity curves of multilayer samples (CNCs/XG)n with n = 1.5 (■), 2.5 (▲), 4 (◆) and 5.5 (●). The solid line is the Fresnel reflectivity.

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