BIREFRINGENT THIN FILMS OF NANOCRYSTALLINE CELLULOSE

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Electrostatic layer-by-layer self-assembled films of nanocrystalline cellulose and poly(allyl)amine hydrochloride (PAH) were prepared by spin-coating and conventional solution dipping. The nanocrystalline cellulose was obtained by acid hydrolysis of cellulose fibres resulting in a stable colloidal suspension of rod-shaped crystals (100-200 nm long by 5-10 nm wide)[1]. Surface characterization was performed by AFM, SEM, XPS and optical reflectometry. Complete surface coverage was achieved leading to smooth films that displayed high film stability under various conditions due to ionic crosslinking. Samples assembled by spin-coating were substantially thicker, leading to iridescent films after only a few deposition steps.[2] As a novel route to prepare ordered films, nanocrystalline cellulose and PAH were adsorbed from solution in a magnetic field.[3] Optical properties for the various film types were compared and birefringence was measured to determine the orientation of nanocrystalline cellulose in multilayered thin films. Surface order was quantified from AFM data with magnetically aligned films displaying the most order followed by radial order in spin-coated films. Surface forces near the films in water and salt solutions were measured by colloid-probe AFM as a function of film thickness, surface charge and cellulose nanocrystal orientation. These aqueous methods for film preparation present an alternative to iridescent coatings made by chemical vapour deposition, and the anisotropic nature of the system imparts a way to tailor optical properties in thin organic films.

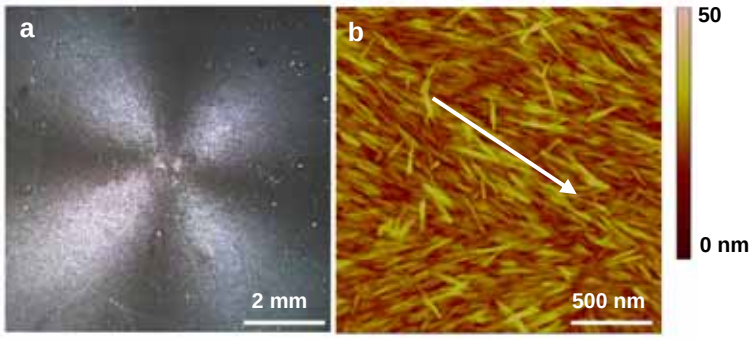
References:

1. Revol, J.F., et al., *Helicoidal self-ordering of cellulose microfibrils in aqueous suspension.* International Journal of Biological Macromolecules. **14**(1992): p. 170.

2. Cranston, E.D. and D.G. Gray, *Morphological and optical characterization of polyelectrolyte multilayers incorporating nanocrystalline cellulose.* Biomacromolecules. **7**(2006): p. 2522.

3. Cranston, E.D. and D.G. Gray, *Formation of cellulose-based electrostatic layer-by-layer films in a magnetic field.* Science and Technology of Advanced Materials. **7**(2006): p. 319.

Figures:



The orientation of cellulose nanocrystals can be seen on many length scales. a) Polarized-light microscopy image of LbL films of $(PAH/cellulose)_{10}$ b) tapping mode AFM height image of the same film.