Single-Fibril Properties and Assembly of Nanocellulose-Based Hybrid Materials

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Optimal design of hybrid materials requires integration of appropriate and efficient approaches to synthesize, functionalize, characterize and process the nanosized species for specific applications. Here, I will give an overview of recent research on characterization and surface modification of nanocellulose fibrils (1) and the fabrication of nanocellulose-based hybrid films and super-insulating foams.

We have studied the structural features on multiple length scales of rod-like cellulose nanoparticles by applying statistical polymer physics concepts and assessed their physical properties *via* quantitative nanomechanical mapping (2). We show clear evidence of a right-handed chirality and statistical analysis of tracked contours shows that the kink angle distribution is inconsistent with a CNF structure consisting of alternating amorphous and crystalline domains. I will demonstrate how the microstructure and mechanical, and thermal properties of various inorganic-nanocellulose hybrids can be tailored by controlling the foaming and assembly of nanocellulose and the inorganic nanoparticles. Examples include nacre-like hybrids based on nanocellulose and calcium carbonate (3), and hybrids of cellulose nanofibrils and titania nanoparticles that results in transparent and flexible free-standing films with a hardness comparable to concrete. Freeze-casting suspensions of cellulose nanofibres, graphene oxide and sepiolite nanorods can produce super-insulating, fire-retardant and strong anisotropic foams. The sepiolite and graphene oxide contribute together with the cross-linker boric acid to the excellent combustion resistance, being significantly better than traditional polymer-based insulating materials (4).

References

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