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Abstract Formulary

Presentation type: **Oral** ✔ **Poster** ☐

Title: 3D printing nanofibrillated cellulose hybrids with anisotropic properties

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ABSTRACT (Space limited to 2200 characters)

Aerogels have different market applications owing to their exceptional properties but currently available solution are limited to the field of thermal insulation in the form of blankets, renders and composites. Silica aerogels are by far the most common material, but recent research points to biopolymer aerogels as an exciting alternative, as they contain different surface functional groups which provide avenues for derivatives, hybrids and applications.
In our current study, we apply our know-how on silica aerogel and CNC-based additive manufacturing [1,2] to successfully 3D print pure cellulose aerogels consisting of nanofibers (CNF) and nanocrystals (CNC). Without the use of any additives or composites, we achieve the required viscosity and rheology needed for printing and our printed materials are able to maintain the high shape-fidelity and pass all the relevant additive manufacturing tests. Printed aerogels have surface areas of 250-400 m2.g-1 and pore volumes of 1.0-2.0 cm3.g-1. Our reference NFC-CNC inks have a unique range of mechanical and thermal properties and we achieve contrasting anisotropic thermal conductivities, depending on the density we reach (24 mW.m-1.K-1 - 65mW.m-1.K-1) as well as an order of magnitude greater mechanical strength in the longitudinal versus transverse direction (80 %). To improve the performance further, hydrophilic silica can be introduced, which lowers the thermal conductivity down to 21 mW.m-1.K-1. Fiber alignment achieved is a function of CNC content and depending on the direction of printing. These biopolymer hybrids, and the possibility to 3D print them, introduces customizability of aerogel thermal and mechanical properties (anisotropy), to extend the potential for oil-water separation, CO2 capture, catalysis, and medicine, to add to aerogel's well-established thermal management applications.

References:

[1] S. Zhao, et al., Additive manufacturing of silica aerogels, Nature. 584 (2020) 387 -392. https://doi.org/10.1038/s41586-020-2594-0.
[2] M.K. Hausmann et al., Dynamics of Cellulose Nanocrystal Alignment during 3D Printing, ACS Nano. 12 (2018) 6926 -6937. https://doi.org/10.1021/acsnano.8b02