NanoCELL - Comprehensive characterization and human toxicological assessment of cellulose nanocrystals along their life cycle for reliable risk assessment and safe use in environmentally friendly packaging materials

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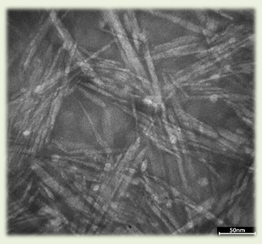
Motivation: Renewable raw materials are increasingly demanded for sustainable packaging solutions, but due to often inadequate material properties, such as low barrier effect and processability, they usually cannot be used directly. With its **excellent barrier properties against oxygen and mineral oil**, cellulose nanocrystals (CNC) offer a **promising alternative to fossil raw materials**. However, before CNC can be used in new, environmentally friendly packaging materials, their human safety needs to be assessed first. **The project NanoCELL deals with improved strategies for extracting and processing CNC from regenerative raw materials for later use in environmentally friendly packaging materials**. NanoCELL thereby tackles the entire CNC life cycle from its production from cellulose-containing raw materials to targeted modifications to its eventual use as coating material.

WP1 - CNC PRODUCTION

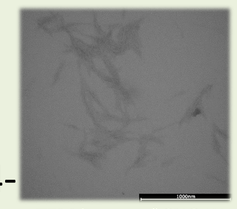
- Successful CNC extraction from α-cellulose (CNC-W) and pulp (CNC-B, CNC-G, CNC-S) by sulfuric acid hydrolysis
  - Variation of sulfuric acid concentration, reaction time and temperature
  - Physico-chemical characterization
    Size: 286nm (CNC-B), 135nm (CNC-S), 178nm (CNC-G), 242nm (CNC-W)
    Zeta potential: -38mV (CNC-B), -47mV (CNC-S), -59mV (CNC-G), -54mV (CNC-W)
  - Determination of target functions which allow for the production of tailor-made CNC



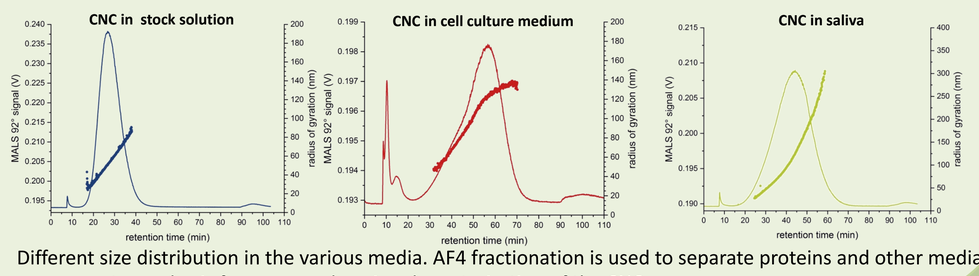
TEM image of CNC-W in stock solution.

WP2 - CNC ANALYSIS

- Innovative analytical methods for physico-chemical characterization of CNC
- Field-flow fractionation
- Electron microscopy
- Successful CNC-characterization via AF4-MALS in biological matrices



TEM image of CNC-W in saliva.



Different size distribution in the various media. AF4 fractionation is used to separate proteins and other media components as a basis for a comprehensive characterization of the CNC

LEGAL FRAMEWORK

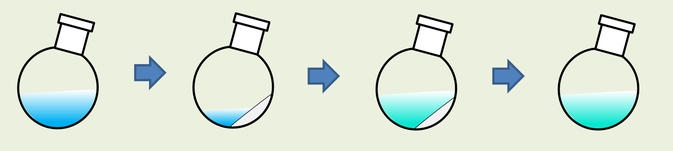
- Standard Operating Procedures
- Collaboration with standardization agencies (DIN, ISO, and OECD)

WP5 - MODELLING

- Development of novel *in silico* methods
- Simulation of CNC degradation, transport and cell response

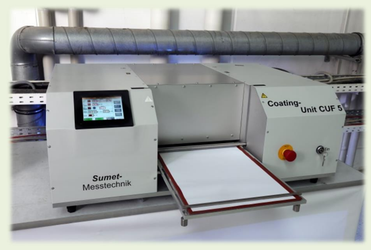
WP3 - CNC PROCESSING

- Formulation

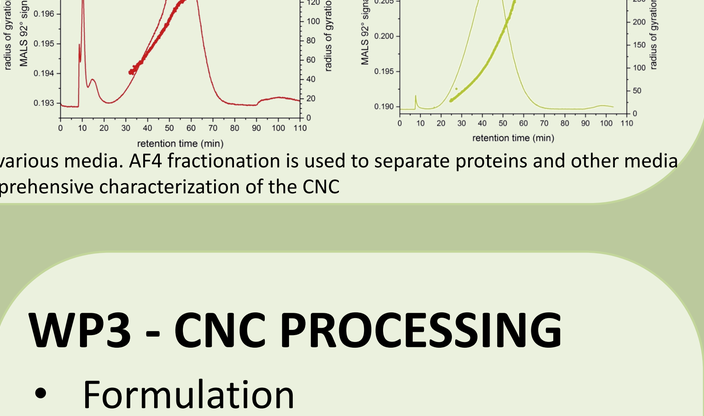


NC aqueous 0.1-1.0 wt% → **concentration (vacuum, < 50°C)** → **Dilution with ethanol (1:3)** → **Sonication (dispersing), centrifugation**

- Coating (labscale)

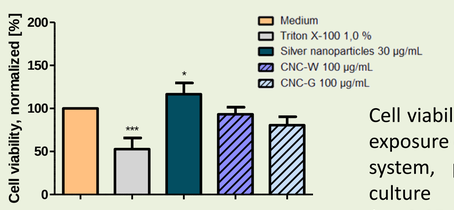


- 3% CNC
- Polylactic acid (PLA), Polyethylen-terephthalat (PET)
- Corona treatment: γ > 40 mN/m
- Coating thickness dry = 0.5-2.5 µm
- Testing of oxygen transmission rate (OTR)

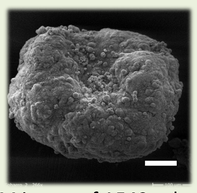


WP4 – CNC TOXICOLOGY

- Hazard studies on the effect of oral and pulmonary CNC uptake
  - *In vitro* model simulating the GI tract
  - *In vitro* model simulating the lung
  - Effect screening of CNC on viability, DNA and ROS generation

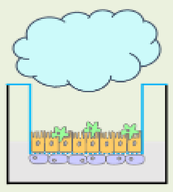


Cell viability, quantified 24 h after single exposure of 100 µg/mL CNC-W via cloud system, presented as normalized to culture medium treated cells. *p< 0.05; ***p<0.001 (one-way ANOVA)



SEM image of A549 spheroid. Scale bar: 100 µm

- Development of a miniaturized cloud exposure system



Miniaturized cloud exposure system

GENERAL INFORMATION

Consortium: 7 partners (2 universities, 2 RTO, 3 SME)
3 associated partners
Duration: 01.03.2019 – 28.02.2022
Coordination: Dr. Florian Meier, Postnova Analytics GmbH
Website: https://www.nanopartikel.info/en/projects/current-projects/nanocell

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