

# Mechanical characterization of cellulose aerogels

Max Zinke\*, Shivangi Aney, Maria Schestakow & Ameya Rege  
 German Aerospace Center (DLR e.V.), Institute of Materials Research, Cologne  
 \*max.zinke@dlr.de

## Introduction

### Cellulose Aerogels

- Natural polymer (3D structure of nanoscale fibrils)
- Renewability and biocompatibility
- Various synthesis methods (e.g. dissolving of polymer chains with effective salt-based solvent  $ZnCl_2$ )
- Good mechanical stability with high flexibility
- Bulk properties highly dependent on synthesis process<sup>1</sup>

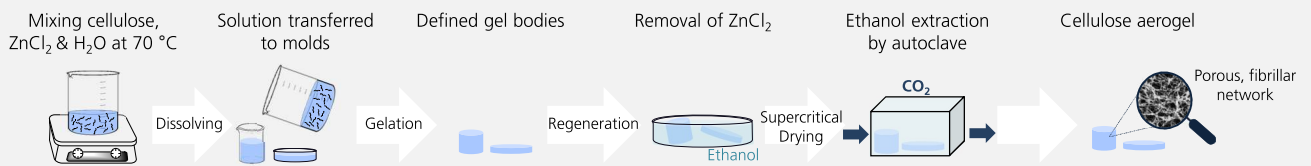


### Motivation

- Deeper understanding of macro- and nanostructure needed
- Computational design of microstructure possible with corresponding data
- Preparation of cellulose aerogels (1-7 wt.-%)
- Investigation of elastic- and, for the first time, inelastic properties
- Quasi-static compression and tension tests

## Experimental

### Cellulose aerogels synthesis process ( $ZnCl_2$ route)<sup>2</sup>

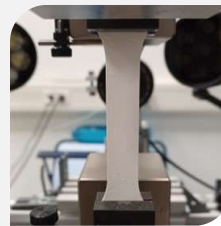


### Mechanical characterization



#### Compression tests

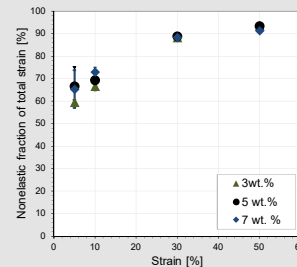
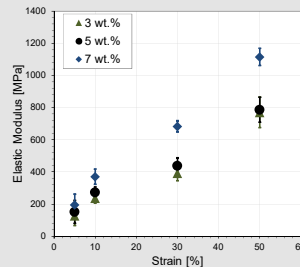
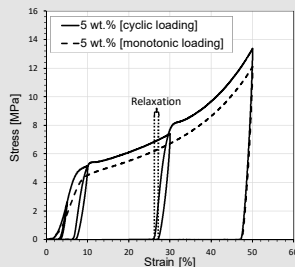
- Machine *Instron*
- Loading cell 10 kN
- Strain rate ~7-9%/min
- Uniaxial, quasi-static loading (5/10/30/50%)



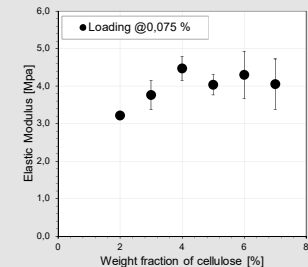
#### Tension tests

- Machine *Instron*
- Loading cell 1 kN
- Strain rate 3%/min
- Uniaxial, quasi-static load

### Compression test data



### Tension test data



## Results

❖ Visible, time dependent relaxation

❖ Significantly increased stiffness at higher wt.-%

❖ Stagnating nonelastic fraction > 30% strain

❖ Increased stiffness at higher wt.-%

The elastic and inelastic properties of cellulose aerogels as a function of weight fraction were determined. The **inelastic properties** could be **reproducibly determined by quasi-static compression**. In combination with elastic properties, the data can be used as a further basis for modeling.

On the other hand, a lower reproducibility was found for the tensile tests, which shows a large influence of the specimen shape and age as well as testing conditions.

