

Introduction

- Organic aerogels** are mesoporous materials characterized by their : high specific surfaces, low densities (< 0.2 g/cm²) and higher mechanical stability in comparison with the other conventional aerogels such as silica aerogels.
- In this work organic aerogel micro-particles are produced via supercritical CO₂-drying as thermal insulating materials.
- The **aim** of this work is to understand the **dominant properties governing the gelation process of lignin aerogels thus final properties.**

Synthesis

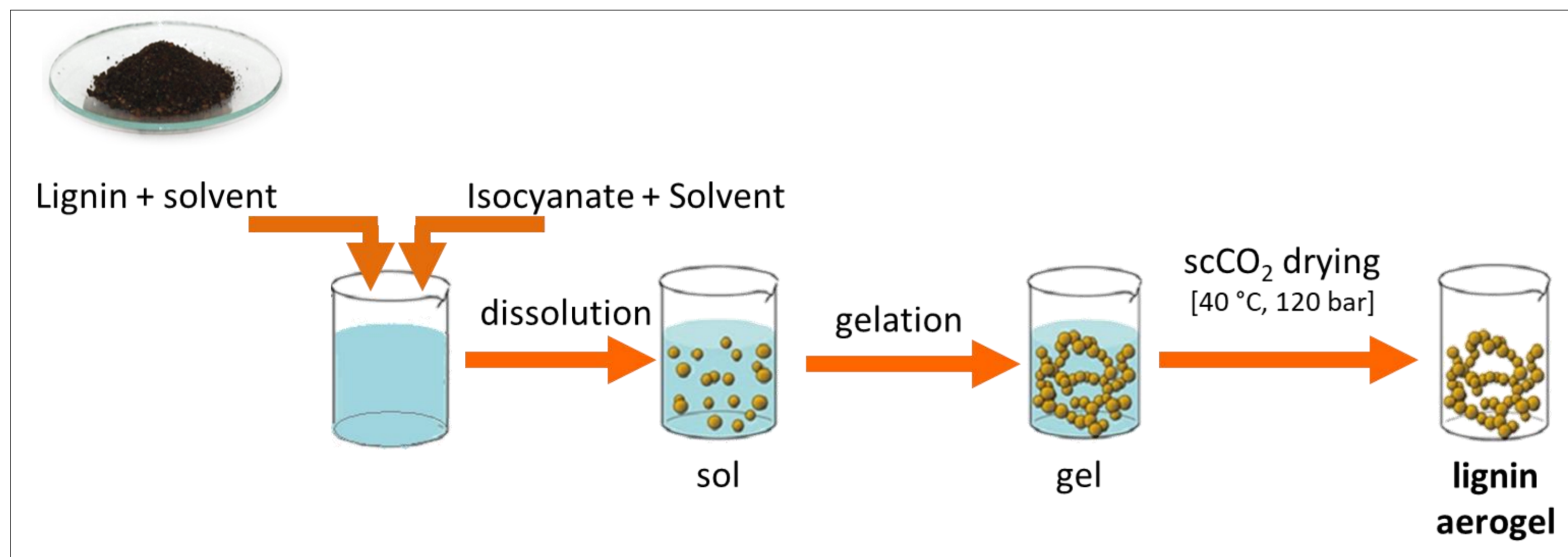


Figure 1: synthesis procedure of lignin polyurethane aerogels.

Lignin Characterization

- Lignin extracted via **klason method**
- Determination of lignin particle properties and functional groups density
- Most dominant properties for **lignin as a biopolyol** performance :

Particle size & solubility.

- Structure varies based on biomass source and extraction method.
- Difficult analysis due to complex undefined structure and low solubility.

Lignin type	Organosolv lignin
Ash content, %	0,11
Klason minus ash, %	93,29
Average OMe, mmol/g	1,09
Aromatic OH, mmol/g	2,96
Total OH, mmol/g	3,47
D50 (µm):	1,39
D90 (µm):	3,45

Role of solvent

- Solubility** was used as first criteria to choose the gelation's solvent.

- Lower solubility than 20 wt% in gelation solvent resulted in no gelation.
- Solvents with higher lignin solubility e.g. DMSO, acetone and pyridine resulted in better gelation & lower gelation time.
- Solubility control **gelation vs precipitation process.**

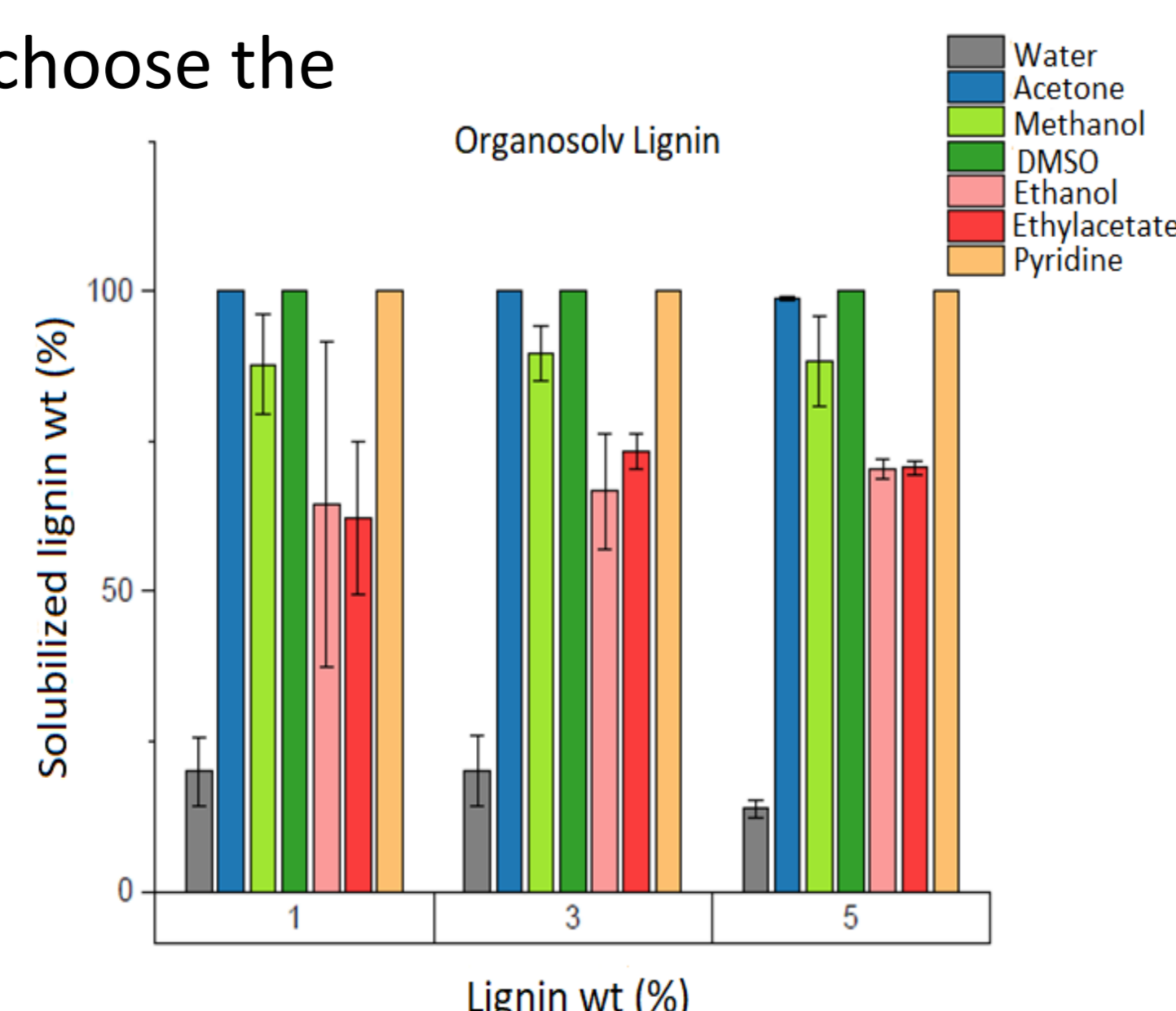


Figure 2: solubility measurements of organosolv lignin in organic solvents.

Shrinkage

- High DMSO concentration** (100 wt %) promote the formation of the following:
- Lower surface area (47 m²/g) & higher thermal conductivity.
- Higher shrinkage** up to 80 % v/v and **Higher density.**

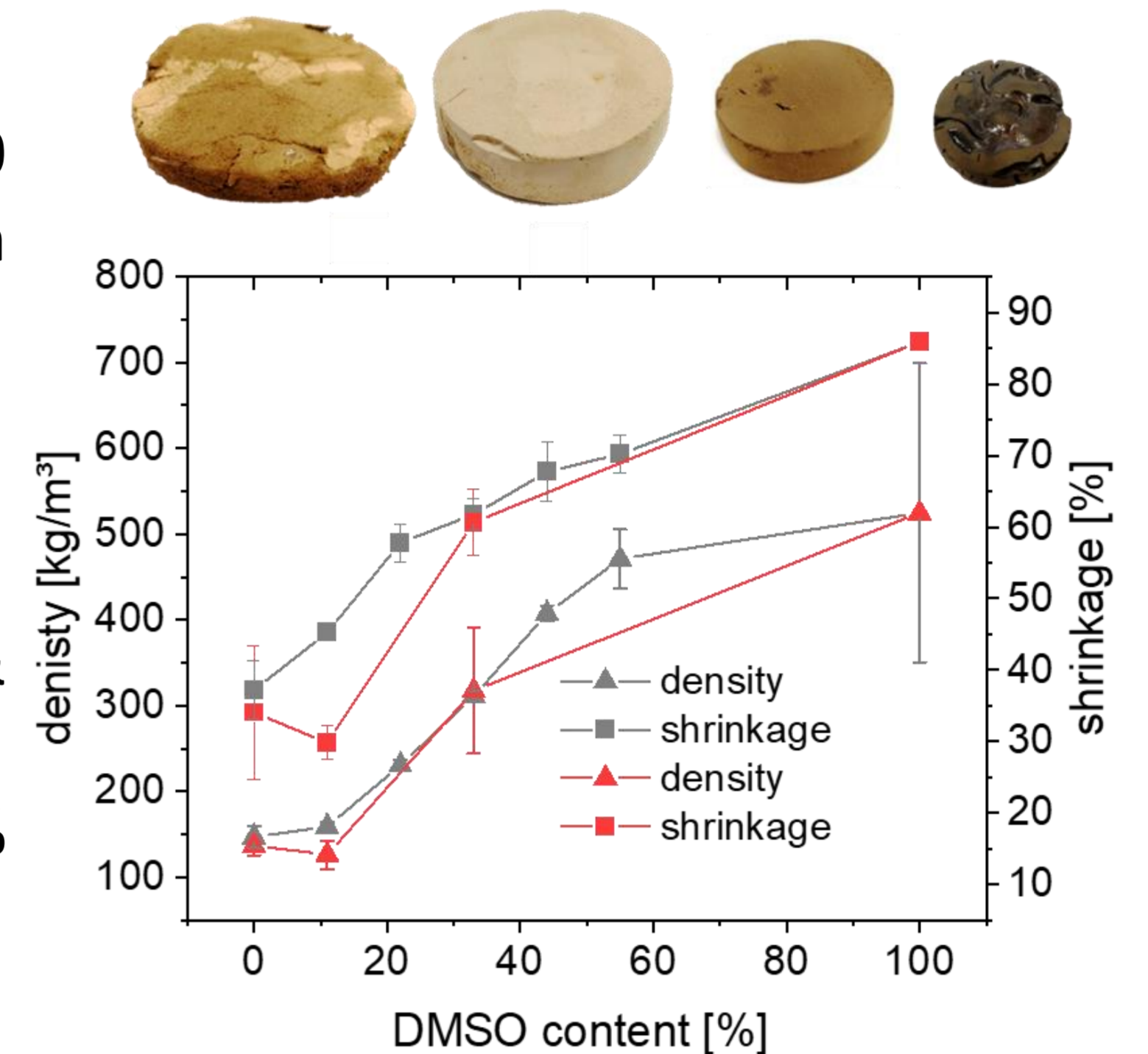


Figure 3: Density and shrinkage results of lignin aerogels.

Phase separation

- Lower DMSO concentration** in solvent blend leads to smaller primary particles.
- Phase separation** due to differences in solubilities between reagents.
- The slower gelation rate gave time to the phase-separated polymer to undergo **spheroidization**.
- Structural changes** result in lower mechanical stability.



Figure 4: SEM images of lignin aerogels with different DMSO concentration.

Lignin aerogel characterization

Solvent blends enabled tailoring the solvent effects and the following properties were achieved:

- Aerogel with 83 % of Lignin.
- Surface area up to 200 m²/g.
- Aerogels with densities between: 120-560 kg/m³.
- Thermal conductivity between 28 – 53 mW/m·K.
- Mechanical strength between 42 – 4418 Kpa.

Further Work and Outlook

- Tailoring the internal structure of lignin based aerogel materials by controlling the sol-gel media.
- Correlation of Lignin-solvent-interaction with gelation's solvent effects.
- Scaling thermal conductivity with structural changes of porous structure.